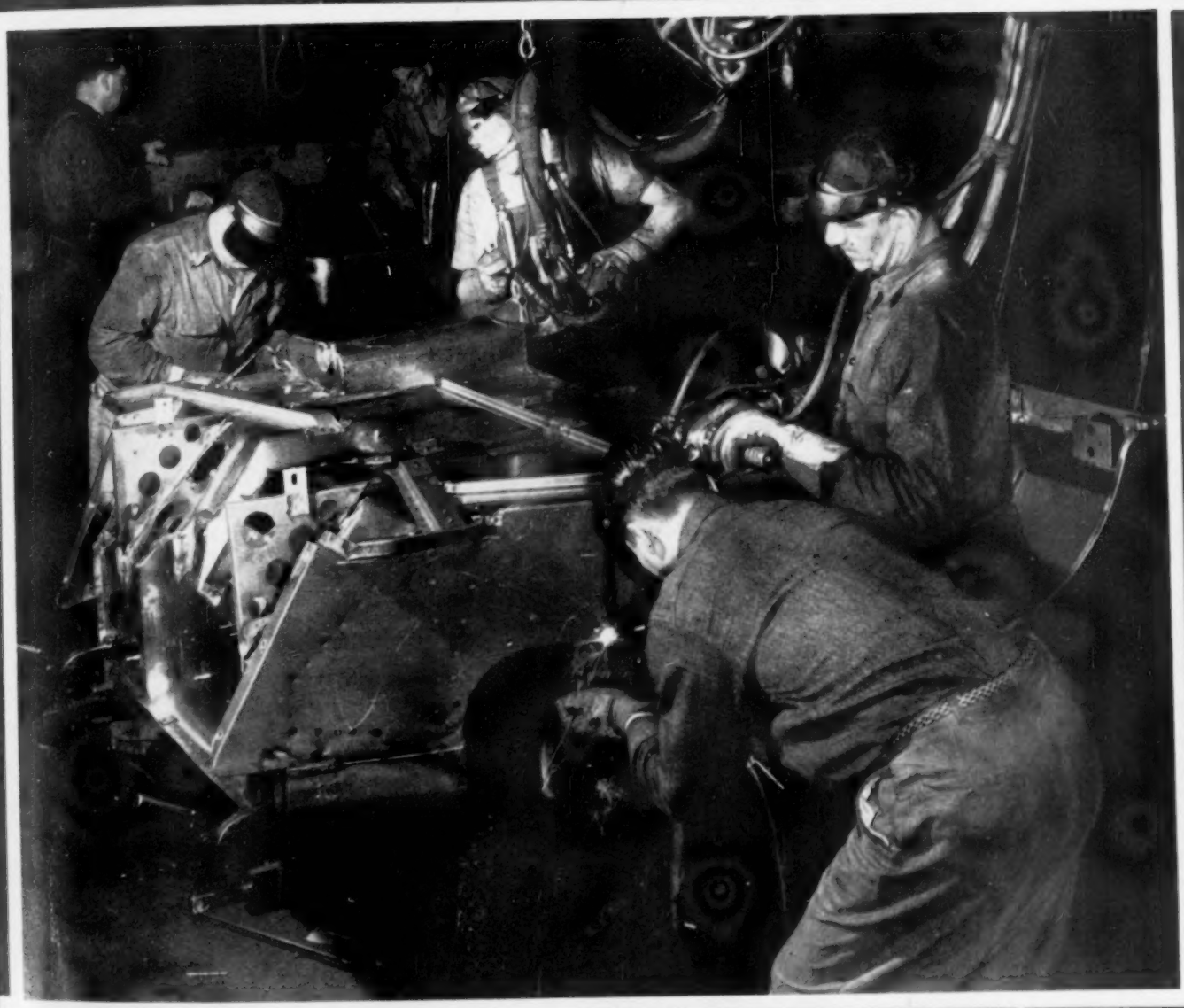
APRIL 1944

The WELDING Journal



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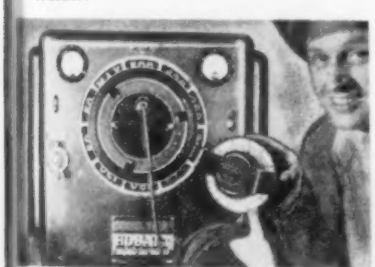

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Published for the Advancement of the Science and Art of Welding

W. SPRARAGEN, Editor

April, 1944

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Front and Rear Sections of Jeep Body Are Brought Together in This Jig for Combination of Spot Welding and Gas Welding Operations at American Central Manufacturing Corporation, Connersville, Ind.

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Oxyacetylene Pipe-Line Installations*

By D. F. Guthrie and R. W. Stewart†

SINCE Pearl Harbor, and even before, a good deal of discussion has been presented on various aspects of welding in war production, emphasizing all those methods and ideas which increase the speed of production in almost any manner. In all these discussions, however, one element in the welding and cutting picture has been largely neglected. The contributions of an oxyacetylene pipe-line installation toward more efficient work and man-hour savings tend to be taken for granted in those plants equipped with such a pipe-line system, and not sufficiently appreciated in those not so equipped. While it is not the primary purpose of this paper to detail with emphasis the economies derived from oxyacetylene pipe-line installations, it should prove valuable to give attention to these advantages in the course of our discussion of the engineering aspects of planning such installations for different types of industries.

It can be said categorically that oxygen-acetylene supply in good-sized industrial plants should be considered a utility service, in exactly the same way as electric current, compressed air, water and steam. Where these gases are used continuously and in quantity, it is no more than logical to provide on-the-spot service outlets at such points, guaranteeing uninterrupted flow of gases at constant pressure. While the advantages of such service are most pronounced as they affect routine production operations, the pipe line can also be designed to accommodate excessive instantaneous loads in emergencies.

Historically, the progressive adoption of pipe-line systems by different industries presents a scattered picture. Pipe lines first came into use in the middle twenties, with the railroad shops being among the pioneers in recognizing the advantages of centralized gas supply and distribution. Steel mills began piping gases to the maximum load points in their plants during these years, and in the early and middle thirties many of them extended their lines to other parts of their plants, until in the late thirties, when they were faced with near-capacity steel production demands, they further extended their systems to take in virtually everything with the exception of small-load stations at outlying points.

Likewise, during the early thirties the railroads, which had previously piped their heavy load points, indicated their acceptance of the efficiency of these systems by augmenting their pipe lines to include the greater part of their shop and yard layouts. During the same period the automotive industry also became aware of the advantages of piping their gas supply, and entered the field even more energetically than the railroads, piping their entire plants completely. Also during the early thirties the few aircraft companies which comprised the industry at that time were aware of the advantages of pipe lines, and most of them installed such systems. The concentration of welding activities in one department made these plants ideal for piping. As the aircraft program expanded, however, the newer companies failed to follow the example set by these pioneers, and it is only recently that they have become aware of this deficiency. At present pipe-line installation activities in the aircraft field are progressively expanding.

During this same period the general industrials, steel fabricators, foundries and forge shops, small parts manufacturers, etc., did not feel the need for pipe-line installations. More recently, due to wartime expansion, a large number of these industrials have been forced to install such systems to provide the volume of gases necessary for peak production. In the same way, prior to the war very few shipyards were piped for oxygen and acetylene, but under the stimulus of the maritime program some of these yards have since been piped, and all of the new shipyards built since the start of the war were piped initially. Shipyards have become a major factor in the use of gases in bulk, distributed through pipe-line networks.

The influence of the war has caused widespread adoption or extension of pipe lines in other industries as well. For example, new steel plants were piped during construction, while older mills have added to their existing installations. Steel foundries have also been piped, some previous to the war and some since. Auto plants converted to aircraft manufacture were already piped, and newly built aircraft plants were piped during the construction of the plant, as were many plants built for aircraft parts manufacture.

As part of this vast expansion of demand for oxygen and acetylene in bulk volumes, our company has built new oxygen-, acetylene- and carbide-manufacturing plants to accommodate wartime requirements.

The advantages of a central gas supply and distribution system are numerous. Detailed cost and time studies are not necessary to show that savings in labor time and money are effected, for it is a demonstrated fact that most pipe-line installations pay for themselves in one or two years. In fact, it is not uncommon for the economies to equal the cost of installation in less than twelve months.

Outstanding among these advantages is that welders need not interrupt their work to change cylinders and readjust regulators. These operations can add up to an appreciable amount of time, all of it nonproductive. Large shops need no longer employ full-time cylinder handlers, and in the storeroom the storekeepers are spared the task of checking large numbers of incoming and outgoing cylinders. Trucking of cylinders to and from the work stations and to the storeroom is eliminated. Floor space is saved—an important item where welding benches are lined up in rows, each with two cylinders nearby. With pipe-line drops to the benches, the elimination of cylinders permits moving the benches closer

* Presented at the Annual Meeting, A.W.S., Chicago, Ill., Oct. 18 to 21, 1943.

† Applied Engineering Dept., Air Reduction Sales Co.

together, restoring hundreds of square feet of floor space for more productive use.

A most important factor is the safety of the gas-line system. In addition to the fact that safety devices are incorporated into the lines, there is the factor of more centralized supervision of the gases at their source, with only low-pressure gases delivered to work-point outlets. Proper sizes of pipe ensure an adequate flow of gases at constant pressure at all times. The elimination of cylinder handling on the part of highly paid welders, together with handling cost savings at the storeroom and in transit, adds up to an appreciable reduction in the cost of the finished product being manufactured.

The discussion to follow comprehends an engineering analysis of problems to be considered in determining oxyacetylene pipe-line capacity in a typical industrial plant. In this discussion the oxygen line will be given primary consideration, but it should be kept in mind that oxygen and acetylene lines almost invariably parallel each other, differing only in pipe capacities. Most industrials maintain a fairly constant ratio between consumptions of oxygen and acetylene, but this ratio differs from one industry to another, according to the processes principally employed. Figure 1 shows the ratios for several industries, itemizing the processes chiefly used.

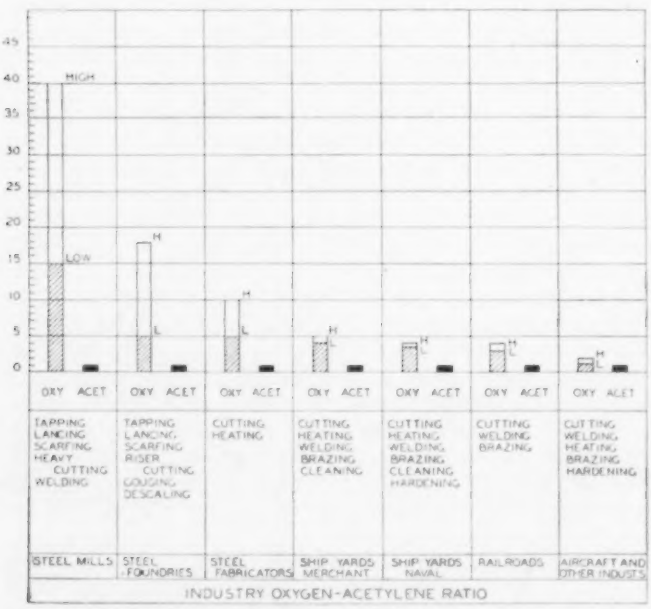


Fig. 1—Approximate Ratios of Oxygen to Acetylene Consumption in Various Industries. Scale Is Proportional Only, with High and Low Ratios of Oxygen Consumption Plotted Against 1.0 for Acetylene

Heavy cutting and scarfing increase the steel mills' oxygen proportion to as much as 40 to 1; shipyards have a 4 or 5 to 1 ratio, roughly, while at the right the aircraft industry, employing the welding flame almost exclusively, has a 1.1 to 1 ratio. These proportions are taken into account in calculating relative pipe diameters, but the formula is not applied empirically to all parts of the pipe-line system. Instead, actual loads in each department are estimated, for within a plant the ratio may be 1.1 to 1 in the welding department and about 15 to 1 in the scarfing department.

In planning a pipe line, the layout of the plant and the gas volume requirements at each point must be considered first. A study of these factors will govern the decisions as to which work points will be included in the pipe-line coverage. The five schematic plant layouts in Fig. 2 illustrate different conditions with respect to the advisability of piping the entire plant or only parts of it. The upper left diagram shows small loads widely scattered; here, the cost of a highly dispersed pipe-line layout should be given serious consideration. Such a situation, where no considerable portion of the load is concentrated at one point, is rare, and it serves here only to illustrate that there are extremes beyond which the installation of a pipe line would be practical more in terms of convenience than of economy.

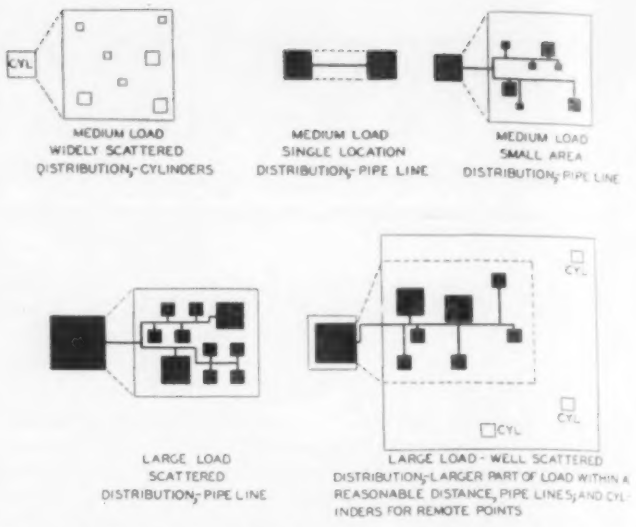


Fig. 2—In These Schematic Plant Layouts the Size of Each Square Represents Volume of Oxygen Load, the Position Represents Relative Location

The top center layout in Fig. 2, showing a single concentrated load point, offers no problem. At top right, medium load points are concentrated over a small area, in which case all points can economically be included in the system, since the main pipes and headers will be of minimum length. The diagram at lower left shows large load areas, more widely scattered. Here, despite the distances covered, volumes are heavy enough to warrant piping the entire plant. In the lower right diagram small load points are interspersed between and around heavy load centers. Here the large points are piped, as are the small points close to the main lines. Notice, however, that distant small points are left to be served by cylinders. In such cases the volume of load versus the distance to the outlets will be weighed against cost, in determining whether to pipe such small loads.

Supposing a plant is already piped, when does it become economical to make additions to the existing pipe line, to take in outlying load centers previously served by cylinder? The upper drawing in Fig. 3 shows a plant properly piped, with three small points not piped.

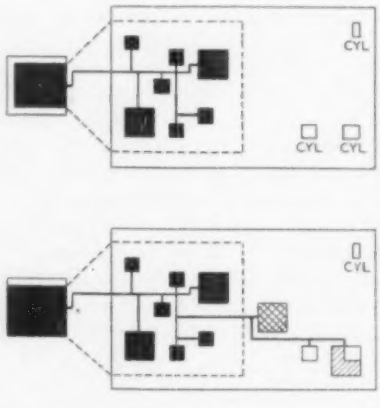


Fig. 3—New Plant Construction or Increased Demand, Shown in Shaded Areas Below, Make It Economical to Extend Existing Pipe Lines, Sometimes Taking in Points Hitherto Served by Cylinders

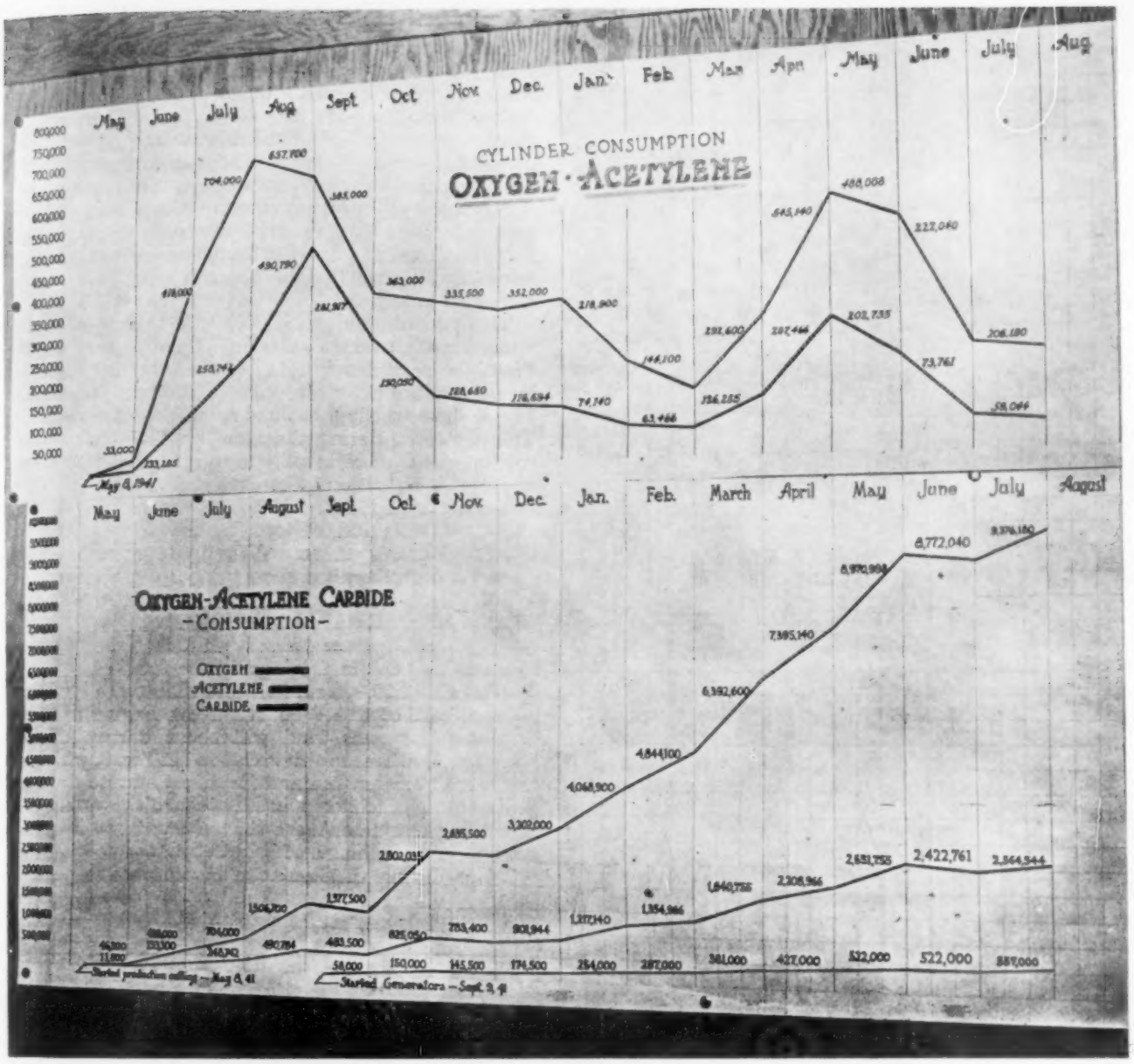

CYLINDER CONSUMPTION
OXYGEN · ACETYLENE
May June July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June July Aug
OXYGEN-ACETYLENE CARBIDE
-CONSUMPTION-
OXYGEN
ACETYLENE
CARBIDE
May June July August Sept Oct Nov Dec Jan. Feb. March April May June July August
Started production ceiling — May 6, 41
Started Generators — Sept. 9, 41

Fig. 4—In This Consumption Record Chart the Upper Chart Shows Cylinder Consumptions, the Lower Shows Gas Consumption Through Pipe Lines

Should a new building demanding pipe-line service be constructed near these points, as indicated by the cross-hatched area in the lower diagram, it becomes practical to include the nearby cylinder stations in the system. Alternately, if one of the original small-load stations should suddenly increase its operations and require pipe-line service, as indicated by the enlarged shaded area at lower right in Fig. 3, any small load points on the way to this new large load station should be incorporated into the system.

An illustration of such growth is revealed indirectly in Fig. 4, a consumption record chart at a West Coast shipyard. Notice here that cylinder consumptions, shown in the upper chart, rose sharply in March and April, indicating that certain yard areas not served by pipe lines were increasing their activities to the point where piping those areas became practical. In May the pipes were installed, and were fully used in June, bringing cylinder consumptions down to a minimum level and throwing the load over to the pipe lines, as shown by the lower chart of pipe-line consumptions.

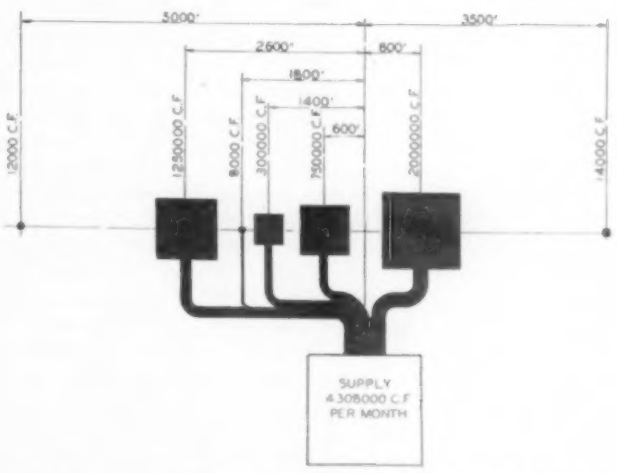


Fig. 5—Proper Location of Central Supply Depot Is Determined by the Combination of Distances and Volumes for Each Load Point

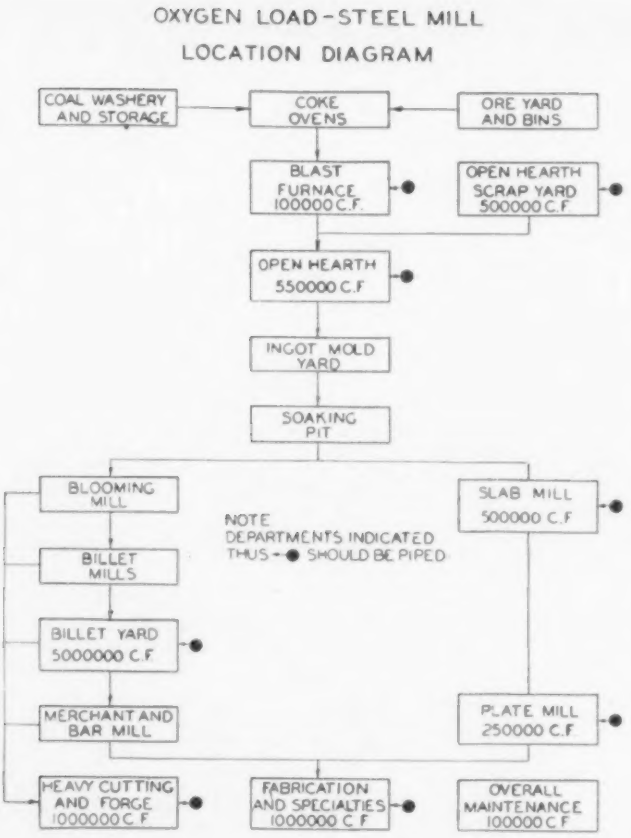


Fig. 6—Organizational Breakdown of a Steel Mill. The Departments Requiring Oxygen Service Are Indicated by Black Circles

The proper location of the central gas supply depot is determined by the combination of distances and volumes of each load point. Other factors such as safety, proximity to other buildings, etc., influence the choice of location, but in general the depot will be placed close to the heavy consumption points. In the hypothetical plant layout in Fig. 5, seven load points of various sizes are located at different intervals. Here a single point requires two million feet of oxygen—almost as much as all others combined—so the supply depot is located closest to this point. Notice also that a small 8000-cu. ft. load was included in the gas distribution system, being along the way to heavy points, while larger loads of 12,000 and 14,000 cu. ft. located 3500 and 5000 ft. away were excluded, to be served by cylinders.

Having covered in general terms the economics of pipe-line installations, to carry the investigation further it is necessary to take a specific plant. For this purpose a steel mill, represented in organizational breakdown in Fig. 6, will be used. Since not all of the components of this steel plant require oxygen, the distribution system will probably be scattered, by-passing some points entirely. In this hypothetical plant the oxygen requirements vary widely, from 100,000 cu. ft. per month in the blast furnace to 5,000,000 cu. ft. in the billet yard. From these figures, calculations of flow requirements and instantaneous peak loads can be made, leading to the final calculation of pipe diameters for each load point. In Fig. 6 it will be noted that one department will be excluded from the pipe-line system, this being the overall maintenance department. General maintenance and construction operations are carried on at all points, and where pipe-line outlets are not available, cylinder service is most practical.

To illustrate the theory and practice followed in determining the correct pipe sizes for each load point, the billet yard, having a monthly demand of 5,000,000 cu.ft. of oxygen, will be used as an example. The immediate object of this calculation is to ascertain the highest instantaneous rate of oxygen withdrawal, since the pipe capacity must be such as to accommodate these momentary peaks. In general, this figure determines the pipe diameter, subject to such adjustments as are necessary to allow for pressure drop over long sections of pipe. In the following series of charts the logic behind each progressive step will be demonstrated, though in practice it is usually not necessary to follow such an elaborate procedure.

The consumption of 5,000,000 ft. of gas is scattered nonuniformly over a 31-day month, of 26 working days. First, the peak demand day of the month is ascertained by observation; for the sake of comparison the chart, Fig. 7, shows the highest load recorded for each Monday, Tuesday, etc., during the month. This chart shows a general rise in consumption during the first part of the week, as production goes into full swing, reaching a maximum on Friday. Although the daily average for the six days is 192,000 cu. ft., the peak day is much higher—310,000 cu. ft. This figure must be broken down even further, however, to obtain the hourly peak, and this has been done in Fig. 8. Here the rate of oxygen withdrawal is plotted for every hour of the three shifts. As might be expected the day shift is uniformly higher, reaching its peak in this case in the fourth hour, with a withdrawal of 29,000 cu. ft., more than twice the average hourly figure of 12,900 cu. ft. Now, assuming that the instantaneous peak load will occur during this peak hour, the final breakdown is charted in Fig. 9, which show the rate of oxygen demand for every minute during the peak hour. Each step in this chart shows the effect of turning on one or more torches at a time in addition to those already burning.

Twice during the hour the instantaneous peak load

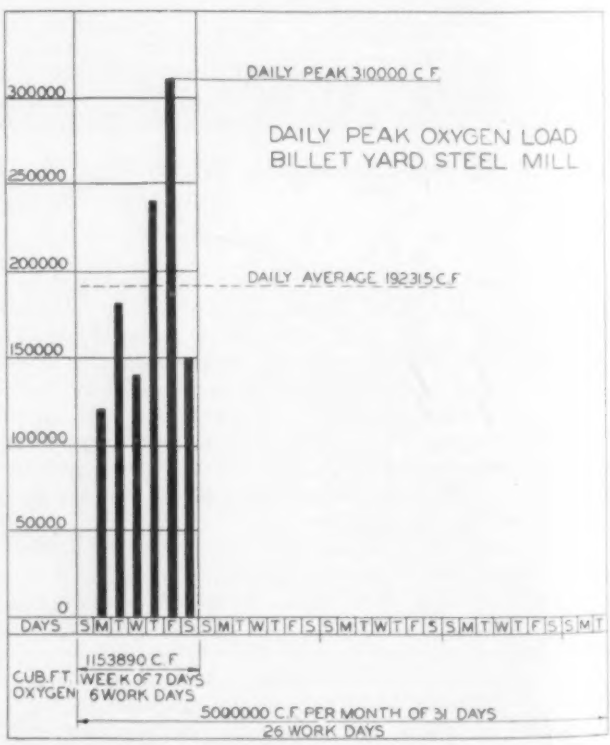

DAILY PEAK 310000 C.F.
DAILY PEAK OXYGEN LOAD
BILLET YARD STEEL MILL
300000
250000
200000
DAILY AVERAGE 192315 C.F.
150000
100000
50000
0
DAYS
S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T
CUB.FT OXYGEN
1153890 C.F.
WEEK OF 7 DAYS
6 WORK DAYS
5000000 C.F. PER MONTH OF 31 DAYS
26 WORK DAYS

Fig. 7—Plotted Here Are the Total Consumptions of the Highest Monday, Tuesday, etc., Encountered During a 31-Day Month. The Peak Day Is Half Again as High as the Average

reached the rate of 40,000 cu. ft. per hour. This, the final figure, determines the size of pipe required to supply oxygen to the billet yard.

To illustrate an opposite condition, Fig. 10 shows hourly loads for the peak day in the Fabrication Shop. Unlike the billet yard, this shop has a fairly even distribution of load over both shifts, with no spectacular peaks of demand. The peak hourly rate here is not far above the average hourly rate.

The wide divergence between average loads and peak loads is amply demonstrated in Fig. 11, which shows both figures for the various steel mill departments, plotted in parallel bars. Since the peak loads run anywhere from $1^1/_2$ to 20 times the magnitude of the hourly averages it is obvious that pipe diameters must be based upon the instantaneous peaks, regardless of how short their duration may be.

After the instantaneous peak rates have been determined for each department or shop it is possible to calculate and specify all details of the piping installation, making allowances only for possible future plant expansion which, if it occurred, would involve tapping of new lines into the lines now being installed. The same applies to anticipated increases in operations within existing plants; pipe diameters are made somewhat larger to accommodate such added load should it occur.

The final tabulation is made in Fig. 12, which lists every department requiring oxygen and shows the periods in days and hours that each of these points operates. The monthly load and the resulting average

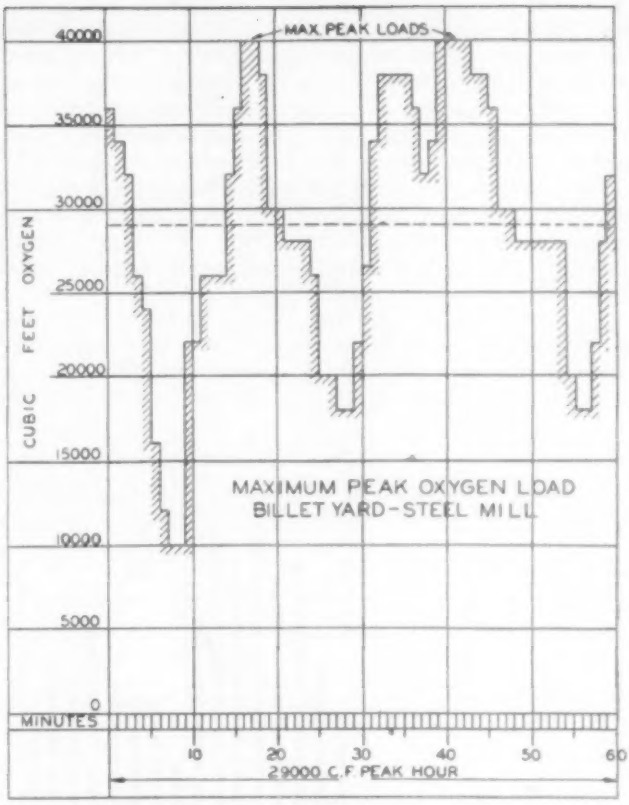


Fig. 9—Final Breakdown Showing Rate of Oxygen Withdrawal During Each Minute of the Peak Hour. From This the Maximum Peak Loads Are Obtained, Enabling Calculation of Pipe Diameter for the Billet Yard

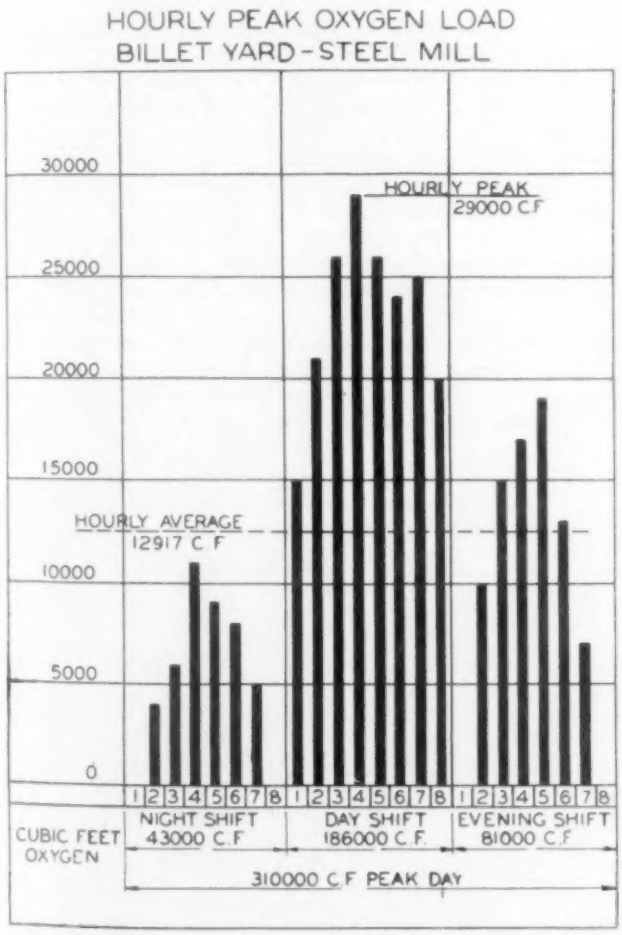


Fig. 8—The Peak Friday in Fig. 7 Is Here Broken Down to Obtain Oxygen Consumption for Each Hour of the Day. Note Again That the Peak Hour Is Much Higher than the Average

hourly loads are shown for comparison with the peak loads, which are derived from the numbers of outlets and operators withdrawing oxygen at one time. The last column lists pipe diameters finally arrived at for each department.

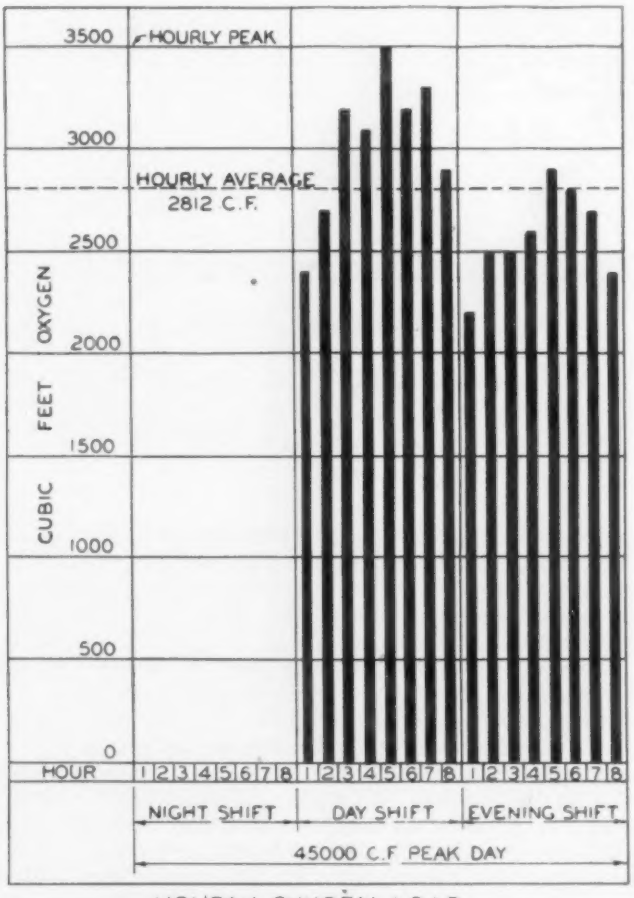
Based on maximum demand figures for each shop, the schematic layout of our steel mill pipe line is as shown in Fig. 13. Branch lines of $1^1/_4$ to 4 in. diameter lead into feeder mains of increasing diameter up to the main supply line, which is a 6-in. pipe. The supply depot at the head of this line is located centrally with respect to volume of gas distribution. The lines are so laid out as to be of minimum length and yet allow for plant expansion, as indicated by the broken lines, without necessitating reconstruction of the pipe-line system.

The same type of diagram for an oxygen distribution system in a 10-way shipyard is illustrated in Fig. 14. While this system is quite extensive, comprising thousands of feet of pipe, its simplicity is obvious, with direct mains leading to each work point. It will be noted, however, that cylinder service should be provided for in the Plate and Structural storage and in the welding school, where consumptions are small. Figure 15 shows how a railroad shop layout would be piped, with every shop included in the oxygen distribution system. In this layout, as in the case of the steel mill and the shipyard, an acetylene distribution system parallels the oxygen system. In each case the pipe diameters are calculated from instantaneous peak loads.

A typical acetylene installation is shown in isometric projection in Fig. 16, with all components of the system represented. This line, after entering the building, branches off into four lateral lines, each equipped with water seals and bursting discs as safety devices. Shut-

off valves are provided on both the inlet and the outlet sides of the water seals, so that in case of disturbances the section affected can be isolated and service maintained without interruption in the balance of the system. The oxygen pipe line is similar to this except that water seals and bursting discs are not needed, and only shut-off valves are provided to divide the system into sections.

The central gas supply for a pipe-line system may be provided in several ways, usually originating in a separate building such as shown in Fig. 17. This building houses in separate rooms the acetylene generators or stationary cylinder manifold, the carbide storage if generators are used, and the oxygen trailer connections or cylinder manifold together with pressure regulators. The building is completely fireproof, and there are no interconnecting doorways between the oxygen and the acetylene portions of the structure. Main pipe lines may lead underground or on an overhead trestle from this central supply house to the points of use.



HOURLY OXYGEN LOAD
FABRICATION-SPECIALTIES SHOP
STEEL MILL

Fig. 10—These Hourly Loads in the Fabrication Shop Show an Opposite Condition from Those in the Billet Yard Shown in Fig. 8. Here the Hourly Peak Is Not Far Above the Average

Depending upon volume requirements, acetylene will be supplied either by generators or by a stationary cylinder manifold. However, no definite monthly consumption figure can be fixed as the maximum beyond which it becomes advantageous to switch from manifolds to generators. Large loads may require the installation of anywhere from two to ten single- or double-rated generators. These are interconnected with valves and headers so that any one or combination of generators may deliver acetylene gas to the pipe line at a time.

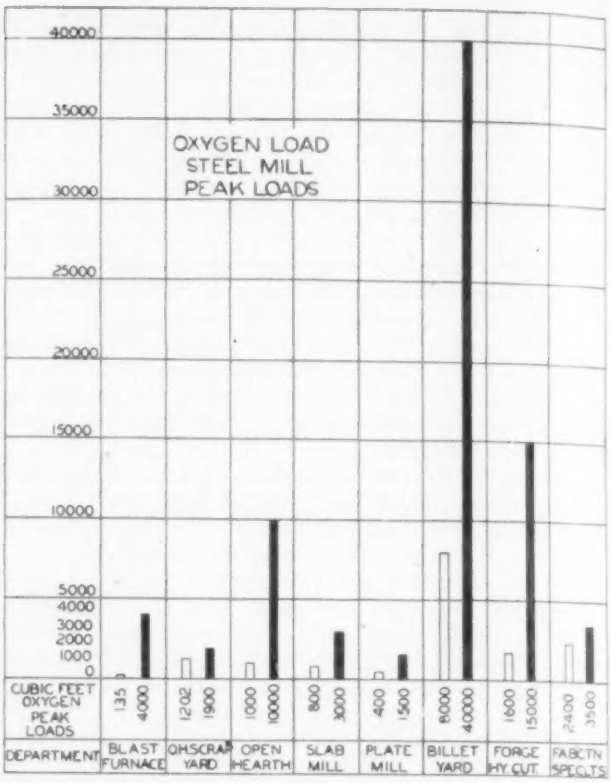


Fig. 11—This Chart Shows the Disparity Between Average Loads (White Bars) and Peak Loads (Black Bars) in Each Department of the Steel Mill

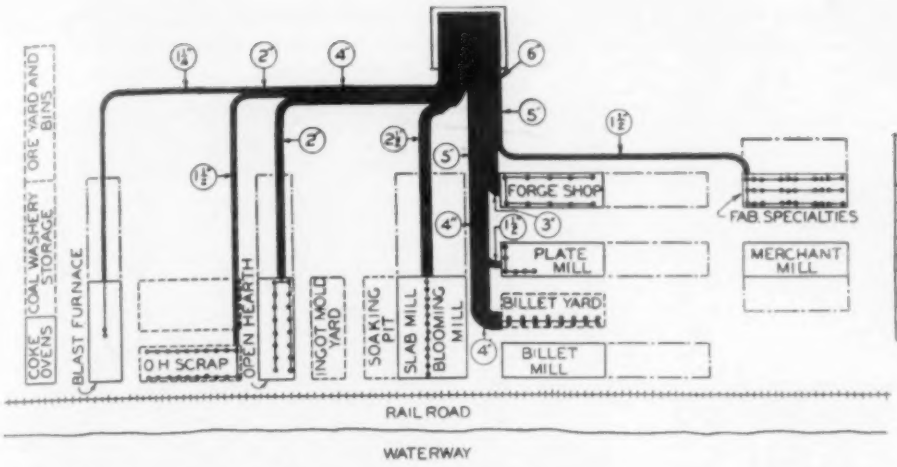
The carbide is stored in an adjacent room, with a hand hoist to facilitate its transfer to the generator room.

Oxygen may also be supplied by a stationary cylinder manifold linked to the pipe line, employing as many cylinders as necessary to meet load requirements, since the manifolds themselves may be employed in multiple. For providing moderate volumes a 20-cylinder manifold such as shown in Fig. 19 is used. This is divided into two banks of ten cylinders each, one bank standing in reserve while the other is in service. Switching from one bank to the other can be done manually or automatically, so that there is not the slightest interruption to service. This uninterrupted service is one of the principal advantages of pipe lines, eliminating the necessity for welders and burners to stop work for changing of cylinders.

OXYGEN LOAD-STEEL MILL

LOCATION	PERIOD	MONTHLY LOAD C.F.	AVERAGE HOURLY LOAD C.F.	WITH-DRAWAL	PEAK LOAD C.F.	LOCATION SUPPLY PIPE DIAM.
BLAST FURNACE	31 DAYS 24 HOURS	100000	135	2-OUTLETS 1-OPERATOR	4000	1¼"
O H SCRAP YARD	26 DAYS 16 HOURS	500000	1202	18-OUTLETS 8-OPERATORS	1900	1½"
OPEN HEARTH	31 DAYS 24 HOURS	750000	1000	16-OUTLETS 3-OPERATORS	10000	2"
SLAB MILL	26 DAYS 24 HOURS	500000	800	12-OUTLETS 2-OPERATORS	3000	2½
PLATE MILL	26 DAYS 24 HOURS	250000	400	6-OUTLETS 6 MACHS	1500	1½
BILLET YARD	26 DAYS 24 HOURS	5000000	8000	16-OUTLETS 8 OPERATORS	40000	4"
FORGE-HEAVY CUTTING	26 DAYS 24 HOURS	1000000	1600	10-OUTLETS 3 OPERATORS	15000	3"
FABRICATION-SPECIALTIES	26 DAYS 16 HOURS	1000000	2400	30-OUTLETS 15 OPERATORS	3500	2½
MAINTENANCE OVERALL	31 DAYS 24 HOURS	100000	134		300	CYLINDERS
PLANT EXCLUDING MAINT		9100000	18537		79200	5"

Fig. 12—Final Tabulation of Figures for Each Department, with Pipe Diameters Calculated Therefrom



STEEL MILL
OXYGEN LOAD VOLUME
AND
PIPE LINE SIZES

LOCATION	PEAK LOADS C.F.	MONTHLY LOAD C.F.
ENTIRE PLANT	79200	9100000
BLAST FURNACE	4000	100000
O.H. SCRAP YARD	1900	500000
OPEN HEARTH	10000	750000
SLAB MILL	3000	500000
PLATE MILL	1500	250000
BILLET YARD	40000	5000000
FORGE-HEAVY CUTTING	15000	1000000
FABRICATION SPECIALTIES	3500	1000000

Fig. 13—Schematic Diagram of Steel Mill Pipe Line, Based Upon Previous Calculations. Numbers in Circles Indicate Main Pipe Sizes. Note That Pipe Layouts Allow for Future Plant Expansion, Represented by Dotted Lines

LOCATION	PEAK LOADS	MONTHLY LOAD
ENTIRE YARD	38000	10000000
PLATE AND STRUCTURAL SHOP	25000	7200000
PLATENS EACH	1000	300000
BUILDING WAYS EACH	2800	300000
PIPE AND COPPER SHOPS	3500	900000
MACHINE-BLACKSMITH SHOPS	2000	700000
SHEET METAL SHOP	600	10000
FITTING OUT PIERS EACH	2000	500000
STORES-APPARATUS REPAIR	-	SMALL
WELDING AND CUTTING SCHOOL	-	SMALL

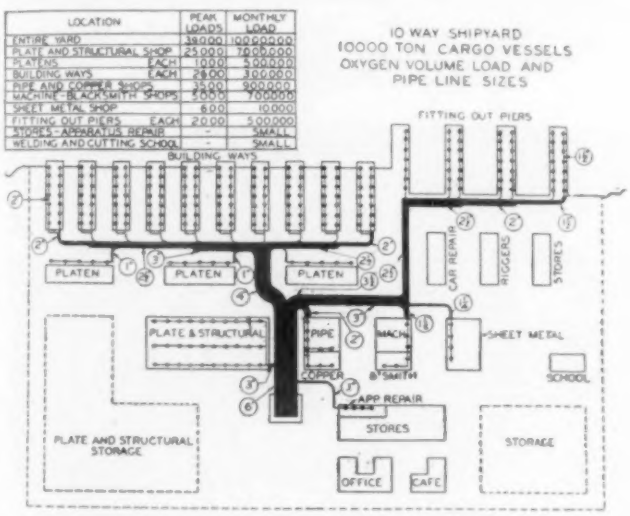


Fig. 14—Pipe-Line System for a 10-Way Shipyard

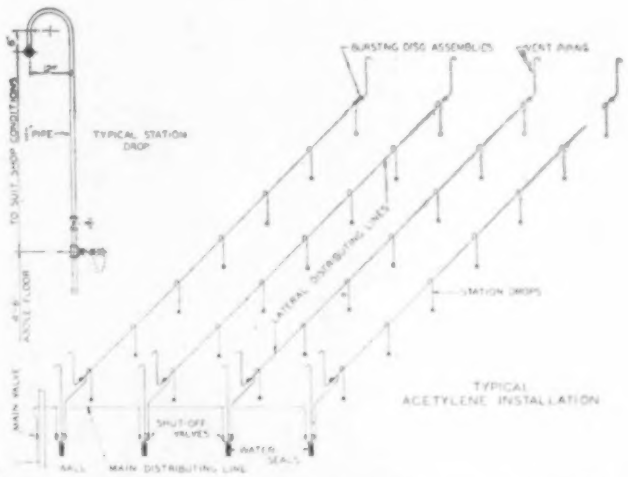


Fig. 16—Typical Acetylene Installation Shown in Isometric Projection

LOCATION	PEAK LOADS	MONTHLY LOAD
ENTIRE SHOPS	9100	350000
FREIGHT CAR SHOP	3000	70000
PASSENGER CAR SHOP	1000	52500
TRUCK SHOP	800	56000
ROUND HOUSE	700	24500
BOILER SHOP	1000	21000
MACHINE AND ERECTION SHOPS	1600	70000
BLACKSMITH SHOP	1000	58000

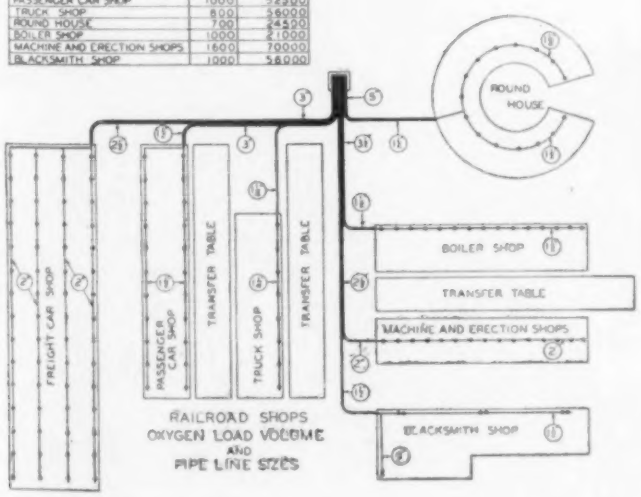


Fig. 15—Oxygen Distribution System for a Railroad Shop Layout. In This and in Figs. 13 and 14 the Acetylene Line Would Parallel the Oxygen Line

Fig. 17—This Central Supply Depot Distributes Oxygen and Acetylene to All Parts of the Plant. It Is the Only Point Where Deliveries Need Be Made

Where oxygen requirements are heavy the gas is supplied in bulk by such means as the trailer trucks shown in Fig. 17, backed up to inlet connections leading to the master regulators. Trailers of this size or larger, carrying thousands of cubic feet of oxygen, eliminate cylinders entirely, and with them the whole system of bookkeeping of incoming and outgoing cylinders. The gas issuing from the trailers is controlled by Flowmaster

regulators in the main control room, shown in Fig. 20, from which it passes out to the pipe-line system under constant pressure. Usually, one trailer is in service while another stands connected in reserve, with automatic valve controls to switch the reserve supply into the line when the service trailer becomes depleted. These valves also permit the reserve trailer to cut in temporarily to permit withdrawals from both trailers simultaneously, to accommodate transitory peak loads.

Figures 21 and 22 offer a remarkable contrast, showing the same welding shop in an Eastern aircraft plant—before and after installation of a pipe line. Formerly (Fig. 21) three gas cylinders stood at each bench, taking up valuable floor space and causing congestion of the

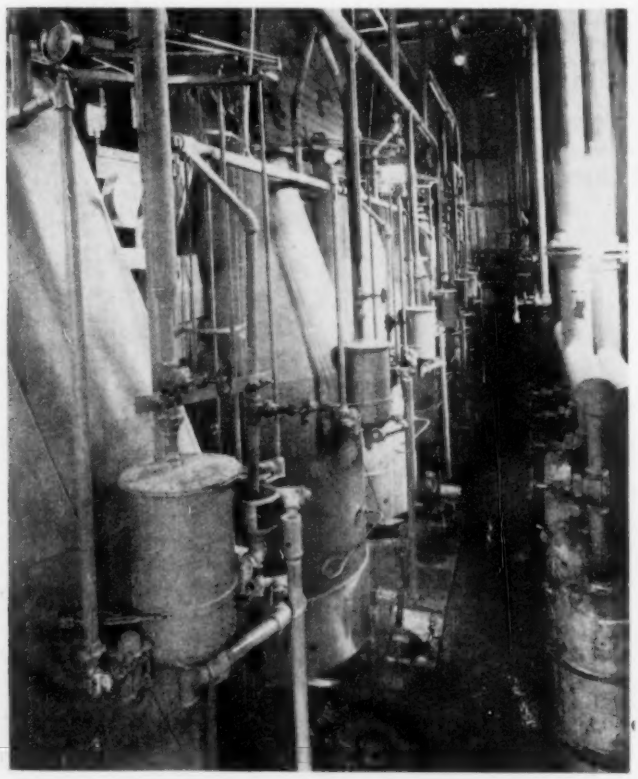


Fig. 18—Acetylene Generators, in Whatever Number Are Needed to Supply the Requirements, Are Interconnected So That Gas Flow Need Never Be Interrupted

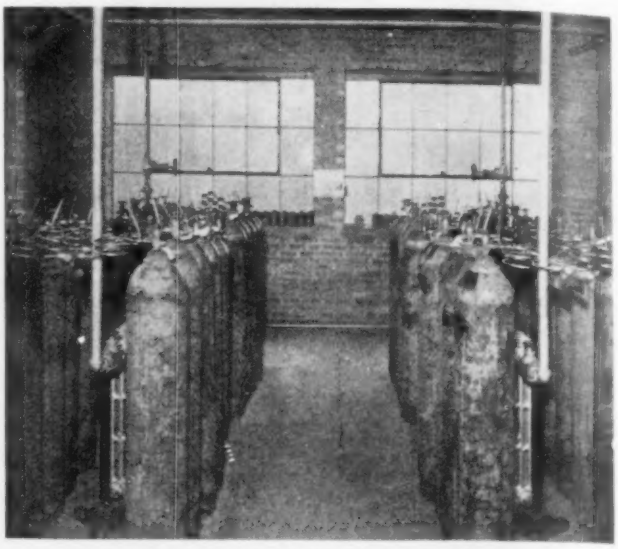


Fig. 19—End View of Two 20-Cylinder Stationary Manifolds. Moderate Needs for Either Oxygen or Acetylene May Be Supplied by a Manifold Similar to This

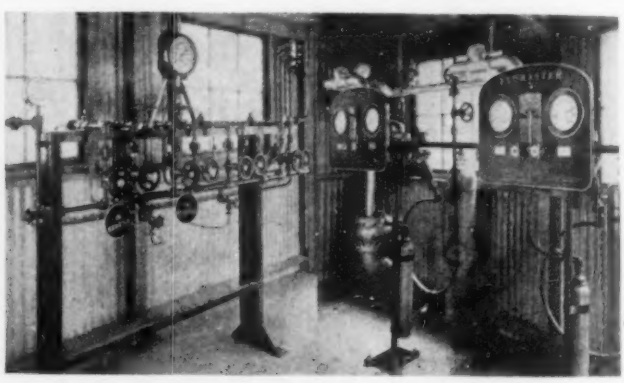


Fig. 20—In the Control House, Flowmaster Oxygen Regulators at Right Maintain Constant Pressure While the Control Valves at Left Permit Withdrawals from One or Two Trailers, with Automatic Switching from a Depleted Trailer to a Full One

Fig. 21—This Aircraft Welding Department Before Pipe-Line Installation Was Cluttered with Numerous Gas Cylinders, Standing Three at a Bench

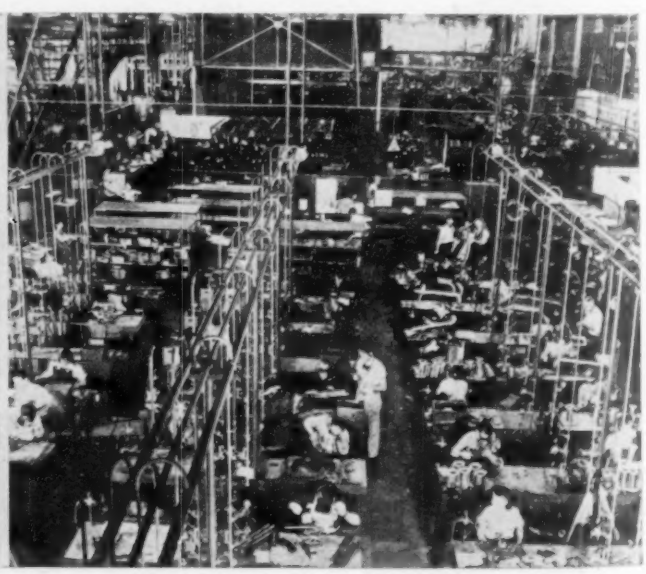


Fig. 22—The Same Shop Shown in Fig. 21 After Pipe Lines Were Installed. Congestion Eliminated, Floor Space Reclaimed and Cylinder Handling by Welders Completely Eliminated

working area. The welders frequently had to stop work to change cylinders and readjust regulators, operations which added up to an appreciable amount of time, all of it nonproductive. Full-time cylinder handlers were employed to truck the cylinders to and from the storeroom and to make changes for women welders. The total cost for handling and lost labor time in this plant was estimated at 75 cents per cylinder.

Figure 22 shows the same aircraft welding department as it looks today. Pipe lines for oxygen, acetylene and hydrogen have saved 600 sq. ft. of floor space, through elimination of cylinders and closing up the space thus made available between workbenches. Though designed for safety and efficiency, the pipe line also presents a neat and orderly appearance. Most important, however, is the fact that highly paid welders can now work without stopping to make cylinder changes. On the operating side, there is the assurance of an adequate flow of gases at all times.

It will be noted in this photo that the individual station branch lines rise in a half loop from the overhead main before running downward to the benches This is to provide flexibility to accommodate expansion in the main line and, further, to prevent particles of dust in the pipe from finding their way to the regulators.

Each major section of the acetylene distribution system is protected by a water seal introduced into the line. These devices serve as flashback arrestors, and also confine the effects of a pipe-line disturbance to the particular section where it might occur. The water seals in Fig. 23 are mounted on an overhead platform to conserve floor space, though they are more commonly placed against a wall or supporting column. Acetylene lines of $1^1/_4$ in. diameter and larger are further protected by bursting discs installed at both ends of every lateral line. These safety devices are positioned so that any explosive wave which finds its way into the line will burst the disc and pass harmlessly out to the open air without damaging the pipe line.

Permanent station outlets at the welding benches may be designed to serve a single operator, or two operators, as shown in Fig. 24. The regulators need not be removed once they are attached, and the welders have the same ready access to their source of gases as they have in drawing water from a faucet. Portable station outlets of various types may be connected to permanent outlets wherever the nature of the work requires mobility. In shipyards, for example, multiple station headers like the one illustrated in Fig. 25 are used on the decks of ships under construction. They are connected to a branch of the shipyard piping system by a hose line, and they are moved about on deck as needed, being made fast at any point by tack welding or by bolting. This manifold header is sturdy and efficient, and it is only one of the many types designed and built by oxyacetylene users to serve their own specific needs.

Control systems for keeping a check on the quantities

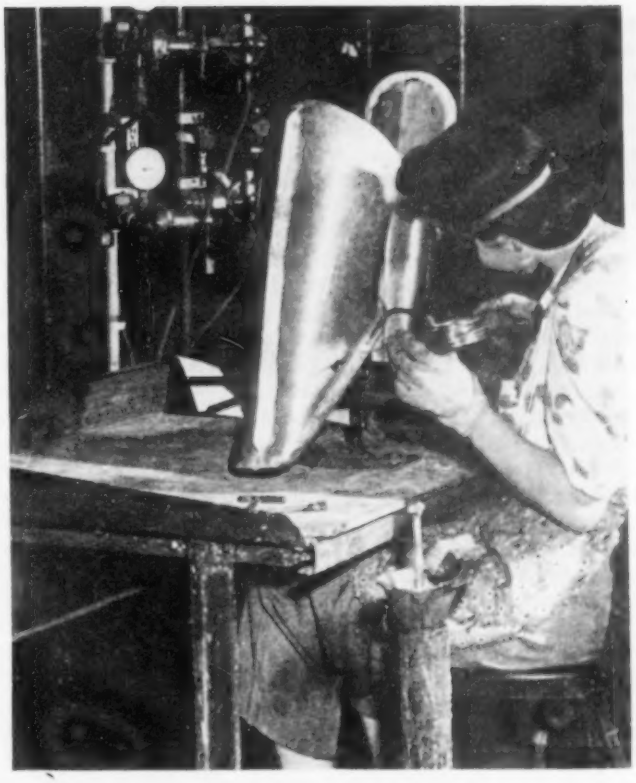


Fig. 24—Station Outlets at Benches Can Be Made to Accommodate One or Two Welders at the Same Bench

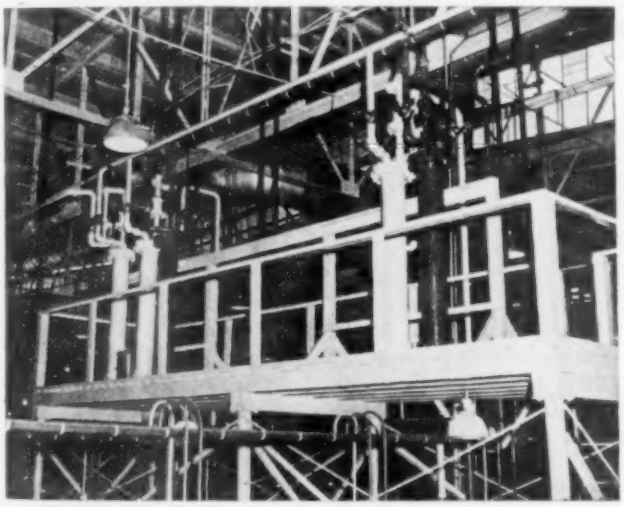


Fig. 23—Waterseals Erected on an Overhead Platform to Conserve Floor Space

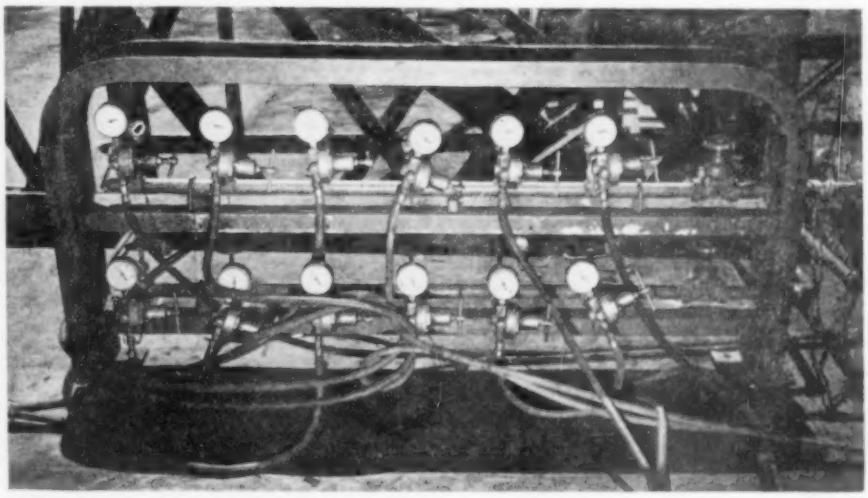


Fig. 25—One Type of Portable Multiple Station Outlet for Oxygen and Acetylene

and locations of gas use may be as simple or as elaborate as desired. Pipe-line consumptions are, of course, easily checked, but in addition recording meters may be installed to enable measurement of gas consumption for a particular day or other working period. Where meters are installed, it is usually for the purpose of measuring oxygen consumption in each shop or department individually, as an aid in cost accounting of each shop's operations. In other words, their use is largely limited to the larger industrials where it is desirable to obtain broken-down data on gas consumption at different locations. Recording meters of the positive displacement type should not be relied upon for really accurate measurement since errors in their performance occur because of wear to moving parts and lack of proper maintenance. The orifice type meter is inadequate as a measuring instrument on oxygen pipe lines because of the uneven demand for oxygen during the working day. Meters when installed become the sole arbiter of the amount of gas delivered to each department. For this reason it is important that any meters installed be high-quality gas meters capable of maintaining accurate registration with a minimum of maintenance and repairs.

Once the oxyacetylene distribution system is installed there is no problem except that of proper operation and maintenance. Since the operation of the system rests in the hands of only one operator on each shift, it is worth while and necessary to employ a skilled, capable man in that post. He should not be a run-of-the-mill laborer, but a man with mechanical experience, capable of making sound decisions and acting upon his own judgment in cases of emergency. He should have a knowledge of pipe fitting, be able to test the pipe-line system, and be able to make repairs to the system or to supervise such repairing. He should be wage-rated in accordance with his ability, which should be in the mechanics' bracket.

The pipe-line system should be inspected periodically. The frequency of such inspection can be determined in cooperation with the manufacturers of the equipment installed. In general, an oxygen system should be inspected every thirty days, particularly on large bulk delivery systems. Stationary cylinder manifolds should likewise be inspected every month, and the same is true for the pipe lines and the fittings on the lines. Acetylene generators should be subjected to a rigid inspection every six months, at which time they should also be thoroughly cleaned out and overhauled.

It goes without saying that to secure the best service from oxyacetylene welding and cutting equipment, all apparatus, such as regulators, hose, torches, tips, etc., should be kept in first-class condition at all times. The gas distribution system is, of course, only a service system operating in the interest of more efficient production operations, and the contribution of all oxyacetylene equipment toward speedier production is contingent upon its being kept in the best operating condition.

In summary, it should be emphasized that while the direct savings resulting from the installation of a gas distribution system are considerable—enough to pay for the installation in a short time—the benefits in wartime are even greater when measured by another standard. Labor time, particularly the time of skilled welders and cutting operators, is saved, and this saving is reflected directly in increased production. In addition, there are further savings in the labor time of storekeepers and receiving clerks, as well as of laborers or truckmen. These factors, together with the advantage of having an adequate flow of gases at constant pressure at all times, all add up to an appreciable reduction in the cost of the finished product being manufactured.

Comments on the U. S. Maritime Commission's "Welding Instructions for Use by Welding Supervisors, Leader-Men, etc., of All Crafts Concerned with Shipyard Welding"*

By James W. Owens†

ABOUT 1928, the Newport News Shipbuilding and Dry Dock Co. submitted a design of a completely welded mast to the American Bureau of Shipping for approval. This mast eliminated staggerd butts then required in the Bureau's Rules.

The Bureau at first rejected the design but subsequently approved it when it was resubmitted with a detailed explanation of the problem of residual stresses in designs incorporating staggerd butts. The accepted mast is shown in Fig. 49 of the writer's paper, "Arc Welding—Its Fundamentals and Economics" published in *Arc Welding* by McGraw-Hill Book Company, Inc.

Figures 8 and 9 of the U. S. Maritime Welding Instructions show this type of fabrication and outline a weld sequence to reduce the liability of weld failures. It would seem therefore that serious consideration should be given to the elimination of a type of fabrication which is potentially not suitable for welded fabrication, regardless of its advantages in the fabrication of riveted ships. In its place we should use simple transverse joints as employed in the fabrication of the mast referred to. This method of fabrication has been previously suggested by others.‡

In the report of the AMERICAN WELDING SOCIETY'S Subcommittee on Hull Construction, published in the same issue of THE WELDING JOURNAL, it was pointed out that the yield point of the material will depend on the "local constraint and direction of stress." This being the case and as yielding of the base metal is required to keep residual and reaction stresses within safe values, it would appear that many of the methods used by the designer and shipbuilder to accomplish this end must be considered as secondary to the approach suggested above. There are cases where the staggering of frames and plating can be used to increase the overall strength of a hull structure without introducing dangerously high residual or reaction stresses because fillet welds would be employed for the attachment of the frames to the plating. These welds have inherently lower residual stresses and the possibility of free movement of frames and other shapes makes it possible to avoid the introduction of high reaction stresses in the structure.

* See December 1943 issue of THE WELDING JOURNAL, p. 985.
† Director of Welding, Fairbanks, Morse & Co.

‡ See Discussion by Ralph E. Spaulding of paper by John Tutin, "Fractures in Welded Ships," September 1943 issue of THE WELDING JOURNAL, p. 723.

Large-Diameter Electrodes Speed Up Shell Welding in Ship Construction

By M. H. MacKusick and R. V. Anderson*

THE horizontal side shell seams on the EC-2 type Liberty ships are prepared with a 30° scarf on each plate, making a total included angle of 60° outboard to a feather edge inboard. In the past it has been the practice to run the outboard beads and the inboard side of the seam was back chipped to clean metal before the inboard passes were run.

When back chipping is used, considerable electrode metal is removed, which is a waste. There is time consumed in the back-chipping operation and additional man-hours must be spent in redepositing the weld metal that was removed.

In the Twin-Arc† method of welding the first passes on the inboard and outboard of the shell are run practically simultaneously; one arc leads the other by a matter of three to four inches. The welds thus deposited are thoroughly fused and the deposited metal is clean.

The Twin-Arc method of welding has been estimated to save approximately 4996 man-hours per hull with a saving of a considerable quantity of electrodes per hull. Twin-Arc welding has saved back chipping and horizontal shell seams are welded using the Twin-Arc procedure for the first passes.

It has been the custom in the past to use no electrodes larger than $^3/_{16}$ in. for this work. One of the projects undertaken in the Yard was the securing of higher amperage welding machines so that larger-diameter electrodes could be used throughout the Yard. The use of larger-diameter electrodes naturally speeds up the production work and in order to accomplish this, procedure must be approved and personnel must be adequately trained, thoroughly tested and given proper supervision.

The Deep Fillet procedure developed at the California Shipbuilding Corp. for welding fillets using E-6020–30 electrodes has more than doubled production footage where the use of this procedure is feasible; also electrodes $^3/_8$ in. in size are being used for conventional welding in the flat position.

As there seemed to be no logical reason why electrodes larger than $^3/_{16}$ in. should not be used on horizontal shell seams, it was decided that a thorough check should be made to find out if there was any reason why larger electrodes should not be used. It was with the thought in mind of utilizing larger diameter electrodes on the horizontal shell seams that the following work was undertaken.

All specimens were welded by shell welders from the Ways. It was proposed that a horizontal simulated section be run in exactly the same manner that this work has been performed on the Ways. Test Specimen W-98 is shown in Figs. 1 and 2.

The next step was to weld a simulated section using $^7/_{32}$-in. electrodes building the weld to flush and using $^3/_{16}$-in. electrodes for cover passes.

The third test section not only used $^7/_{32}$-in. electrodes to flush up but also to make the cover passes with the exception of the final finish bead.

* Welding Engineer and Testing Engineer, respectively, California Shipbuilding Corp.

† Twin-Arc Welding is a term used to define a welding procedure in which two welders deposit root passes in a double Vee groove, working simultaneously from opposite sides of the plate. The two arcs are maintained from 2 inches to 6 inches apart, depending on the root opening and plate thickness. Back-chipping is eliminated.

Fig. 1—Specimen W-98, Outboard Side

Fig. 2—Specimen W-98, Inboard Side

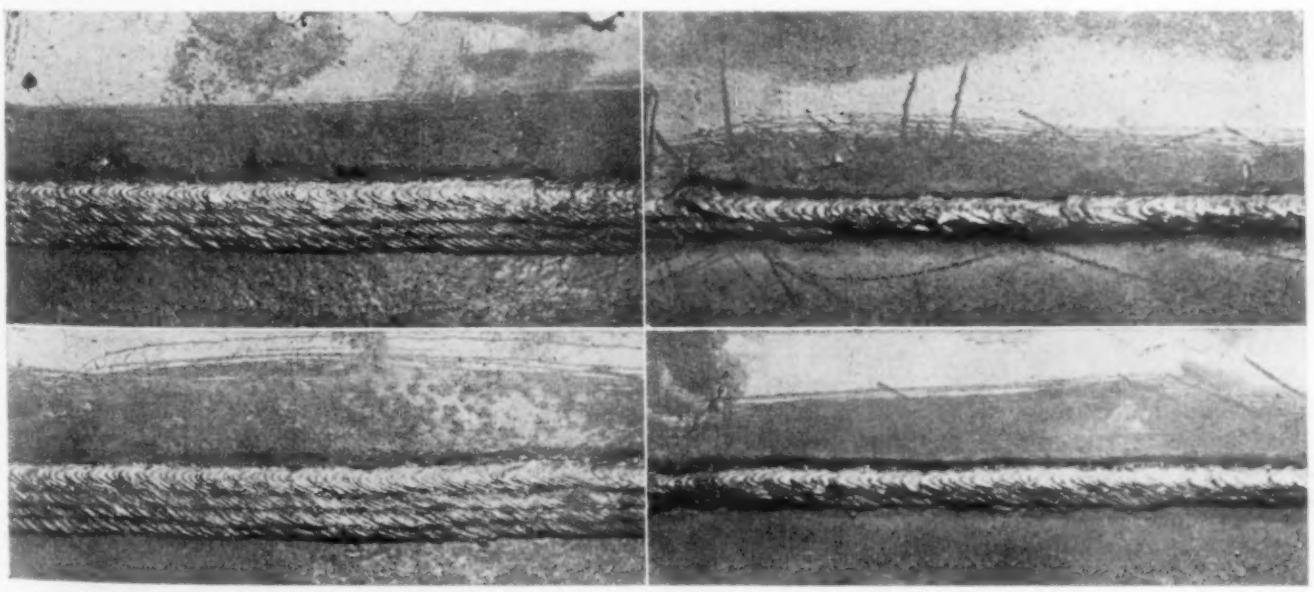


Fig. 3—Specimen W-99, Outboard Side

Fig. 4—Specimen W-99, Inboard Side

Fig. 5—Specimen Y-1, Outboard Side

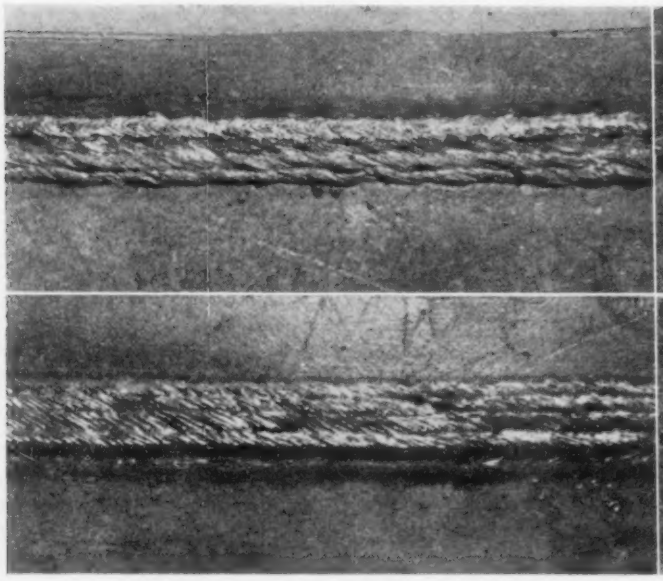


Fig. 6—Specimen Y-1, Inboard Side

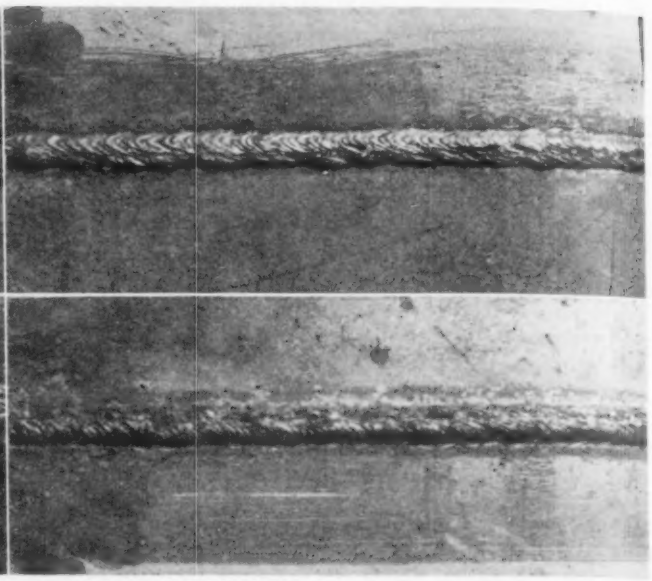


Fig. 7—Specimen Y-2, Outboard Side

Fig. 8—Specimen Y-2, Inboard Side

The fourth test section was made with $^1/_4$-in. electrodes to flush and $^7/_{32}$-in. electrodes for the cover pass.

A fifth test section was tried with $^5/_{16}$-in. electrodes but the welders were unable to properly handle the metal.

The welding data for Specimen W-98 (Figs. 1 and 2) are as follows:

Passes 1 and 2—Inboard and outboard, Twin-Arc, $^3/_{16}$ in. A.W.S. E-6010.
Passes 3 and 4—Inboard and outboard, $^3/_{16}$ in. A.W.S. E-6010.
Passes 5, 6, 7, 8, 9, 10, 11 and 12—Outboard, $^3/_{16}$ in. A.W.S. E-6010.

Figure 1 shows the cover passes as welded on the outboard side, and Fig. 2 the inboard side of Specimen W98.

The welding data for specimen W-99 are as follows:

Passes 1 and 2—Inboard and outboard, Twin-Arc, $^3/_{16}$ in. A.W.S. E-6010.
Passes 3 and 4—Inboard and outboard, $^3/_{16}$ in. A.W.S. E-6020.
Passes 5, 6, 7 and 8—Outboard, $^7/_{32}$ in. A.W.S. E-6020.
Passes 9, 10, 11 and 12—Outboard cover, $^3/_{16}$ in. A.W.S. E-6010.

Figure 3 shows the cover passes as welded on the outboard side, and Fig. 4 the inboard side of Specimen W99.

The welding data for Specimen Y-1 are as follows:

Passes 1 and 2—Inboard and outboard, Twin-Arc, $^3/_{16}$ in. A.W.S. E-6010.
Passes 3 and 4—Inboard and outboard, $^3/_{16}$ in. A.W.S. E-6010.
Passes 5 and 6—Outboard, 1 down, 1 up, $^7/_{32}$ in. A.W.S. E-6020.
Passes 7, 8 and 9—Outboard, cover, $^7/_{32}$ in. A.W.S. E-6020.
Passes 10—Outboard, cover, finish, $^3/_{16}$ in. A.W.S. E-6010.

Figure 5 shows the cover passes as welded on the outboard side, and Fig. 6 the inboard side of Specimen Y-1.

The welding data for Specimen Y-2 are as follows:

Passes 1 and 2—Inboard and outboard, Twin-Arc, $^3/_{16}$ in. A.W.S. E-6010.
Passes 3 and 4—Inboard and outboard, $^3/_{16}$ in. A.W.S. E-6010.
Passes 5, 6 and 7—Outboard, $^1/_4$ in. A.W.S. E-6020.
Passes 8, 9, 10 and 11—Outboard, cover $^7/_{32}$ in. A.W.S. E-6020.

Figure 7 shows the cover passes as welded on the outboard side, and Fig. 8 the inboard side of Specimen Y-2.

A time study was made on these four simulated sections and it was estimated that the Specimen Y-2 could be run in 25 to 30% less time than Specimen W-98, representing the method by which these horizontal seams have been welded in the past.

The method of application of the weld beads in Specimen Y-2 is such that it may be handled and followed by the average run of shell welders, with less chance of poor workmanship which might be encountered to a greater extent in running a larger number of smaller weld beads. The soundness of the deposited weld metal is shown by the etched specimens in Fig. 9.

The question naturally arises as to whether or not a weld made with multiple passes of a smaller-diameter electrode is more ductile than a fewer number of passes made with a larger diameter electrode. In order to make this determination and to subject these welds to as great an adverse condition as possible, free bends were made putting in turn the inboard and outboard weld beads in tension.

Both the inboard and outboard weld beads are left on

Fig. 9—Etched Section, Specimens W-98, W-99, Y-1 & Y-2

Fig. 10

Fig. 11

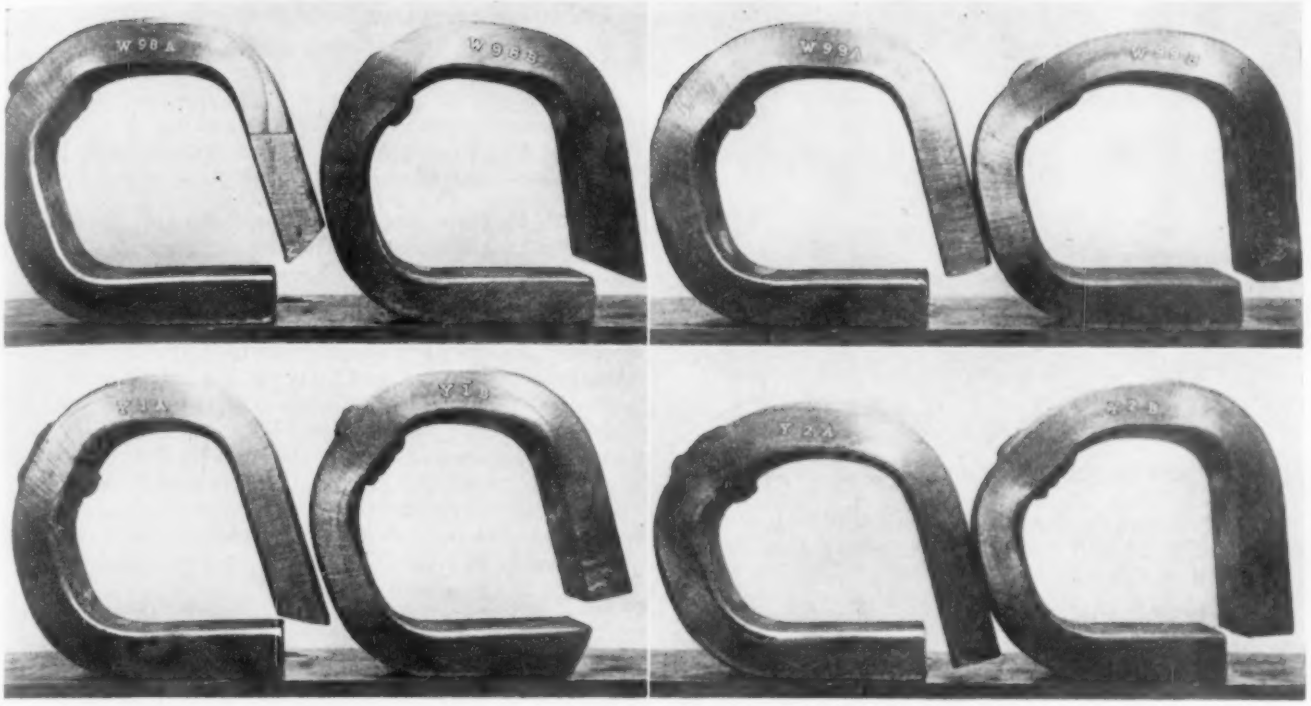


Fig. 12

Fig. 13

Figs. 10–13—Results of Bend Tests

the shell; consequently the weld beads were left on these specimens for the purpose of simulating actual stress conditions that might be encountered by the seams and to show up any difficulties that might exist from fusion lines or undercutting, if any.

Figure 10 to 13 show the results of these free bend tests.

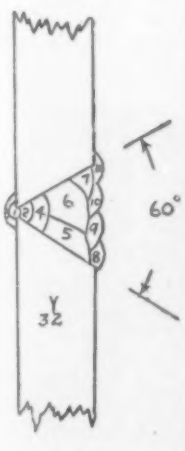
Based on the above tests it would seem that so far as practical usage is concerned, there is little or no loss of ductility in using larger-diameter electrodes for horizontal side shell seams; and that the Twin-Arc procedure completed with the use of larger electrodes would represent a decided saving in costs and man-hours per hull.

While the use of $^{7}/_{32}$-in. electrodes for the cover passes produces weld beads of excellent quality, it was decided for the time being to confine our efforts to $^{3}/_{16}$-in. electrodes for these cover passes.

It was also thought desirable to determine the tensile strength of the welds to be made with this procedure. An additional simulated test section was welded in accordance with the procedure outlined for Test Specimen Y-2 with the exception that the cover passes were made with $^{3}/_{16}$-in. electrodes. This method of edge preparation of horizontal seams is for the EC-2 Liberty ship.

The welding sequence was as follows:

Passes 1 and 2—Inboard and outboard, Twin-Arc, $^{3}/_{16}$-in. A.W.S. E-6010.



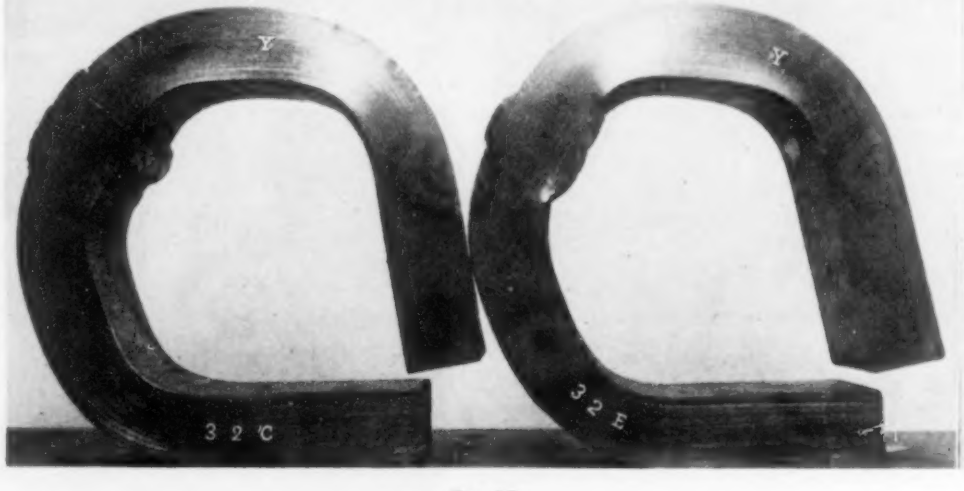


Fig. 14

Fig. 15

Fig. 16

Fig. 14—Sequence Specimen Y-32
Fig. 15—Root and Face Bends, Specimen Y-32
Fig. 16—Etch Section, Specimen Y-32

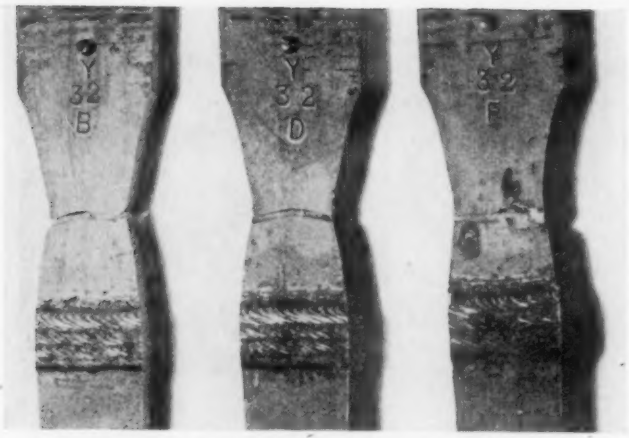


Fig. 17—Tensile Test, Specimen Y-32

Passes 3 and 4—Inboard and outboard, $^3/_{16}$ in. A.W.S. E-6010.
Passes 5, 6 and 7—Outboard, $^1/_4$ in. A.W.S. E-6020.
Passes 8, 9, 10 and 11–Outboard cover passes, $^3/_{16}$ in. A.W.S. E-6010.

Figure 14 shows the welding sequence of the passes in their approximate position as deposited. The face and root bends for these specimens are shown in Fig. 15. The etched specimen from the section is shown in Fig. 16.

Tensile tests were also made on this same test section. The results were as follows:

Specimen	Thickness In.	Width In.	Area Sq. in.	Load, Lb.	Ultimate Strength, Psi.
Y-32, B	0.633	1.501	0.950	59,180	62,294
Y-32, D	0.634	1.499	0.950	59,400	62,526
Y-32, F	0.633	1.501	0.950	59,760	62,905

The tensile test specimens all failed in the plate metal. Photograph of the specimens is shown in Fig. 17.

As production work has started on the AP-3 Victory ships, and as the horizontal side shell edge preparation is different than for the EC-2 Liberty it was decided to simulate the edge preparation for the horizontal seam of the AP-3 Victory ship to determine the most economical way of welding this seam with the preparation involved.

The welding sequence was as follows:

Passes 1 and 2—Inboard and outboard, Twin-Arc, $^3/_{16}$ in. A.W.S. E-6010.
Passes 3 and 4—Inboard and outboard, $^3/_{16}$ in. A.W.S. E-6010.
Passes 5 and 6— Inboard, $^3/_{16}$ in. A.W.S. E-6010.
Passes 7, 8 and 9—Outboard, $^3/_{16}$ in. A.W.S. E-6010.

Figure 18 shows the edge preparation and the welding sequence of the passes and their approximate position as deposited.

A simulated test section was set up with a $^1/_{16}$-in. opening. Two cover passes were sufficient to finish the seam; however, for the purpose of comparison, two cover passes were run on one side and three on the other. Preliminary test specimens were also run with wider fitups. As the fit-up opening increases in size the number of cover passes necessary to complete the seam would naturally be increased. Also $^7/_{32}$- or $^1/_4$-in. electrodes could be substituted for $^3/_{16}$-in. electrodes used with the $^1/_{16}$-in. opening, making it possible to weld passes 3 and 4 with one pass instead of placing an extra pass with $^3/_{16}$-in. electrodes in the case of wider fitups.

It would therefore seem advisable in the horizontal side shell seams to hold the fitup to within prescribed

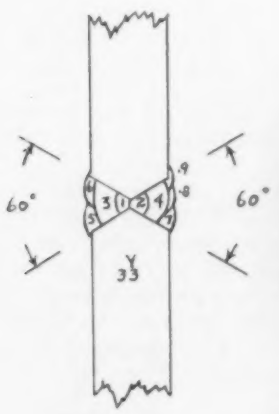


Fig. 18

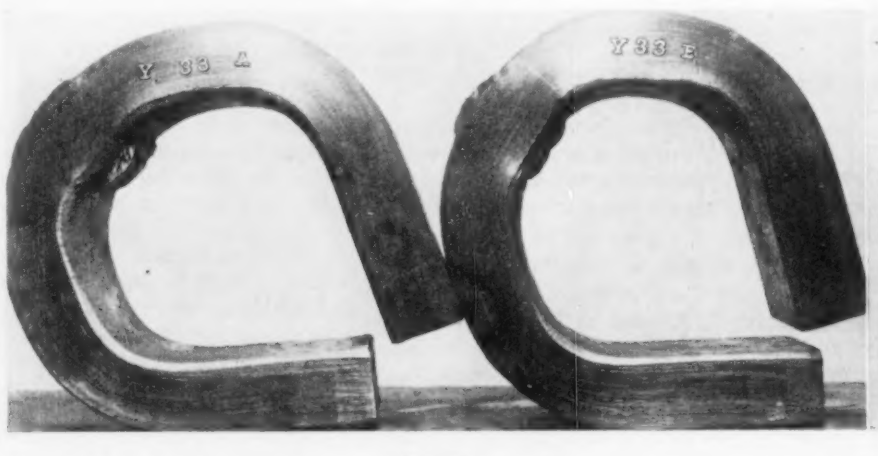


Fig. 19

Fig. 20

Fig. 18—Edge Preparation and Welding Sequence, Specimen Y-33
Fig. 19—Face and Root Bend Tests, Specimen Y-33
Fig. 20—Etched Section, Specimen Y-33

Fig. 21—Tensile Test, Specimens Y-33

limits with the viewpoint to economy of electrodes and the man-hours necessary to finish the seams. The face and root bend tests are shown in Fig. 19. The etched specimen from the section is shown in Fig. 20.

The tensile test specimens all failed in the plate metal. Photograph of the specimens is shown in Fig. 21.

In summing up this work that has been done on simulated horizontal shell seams, with the edge preparation described, we have in all instances complete penetration, sound welds, good appearance in the cover passes, good ductility, and strength in the welds that exceeds that of the plate metal.

Three tensile tests were also made from coupons cut from the test section. The results were as follows:

Specimen	Thickness In.	Width In.	Area Sq. in.	Load, Lb.	Ultimate Strength, Psi.
Y-33, B	0.625	1.501	0.937	60,140	64,183
Y-33, D	0.624	1.501	0.937	60,000	64,034
Y-33, F	0.624	1.502	0.937	59,600	63,607

Welded Plate-Girder Bridge Separates Connecticut Highways*

By John F. Willis†

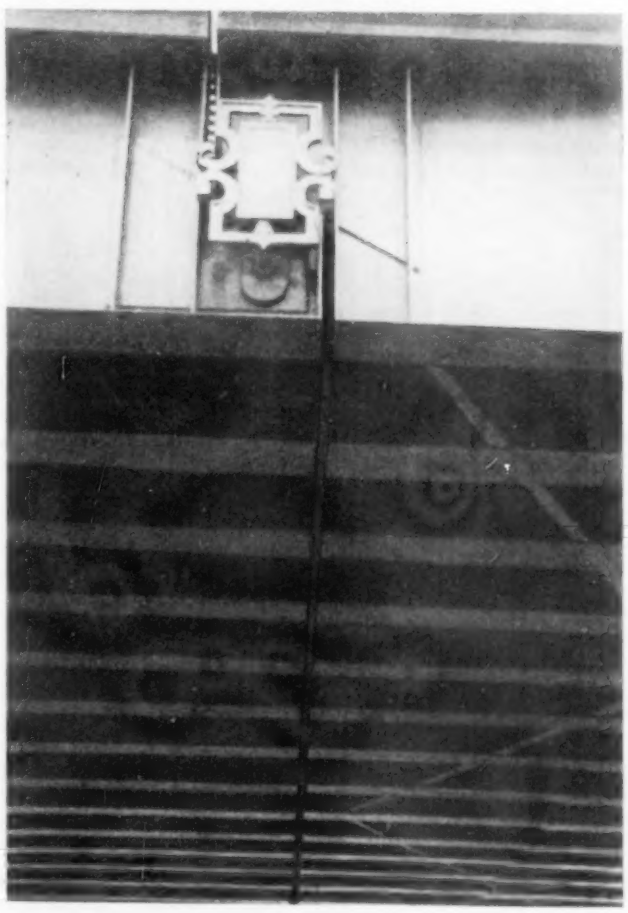
SITUATED in the town of Wethersfield, Conn., the Jordan Lane Bridge is one of nine grade separations which now carry the Hartford Bypass, a dual parkway connecting U. S. Route No. 5 with the new Connecticut River Bridge between Hartford and East Hartford. Because of the irregularity of the intersection to be overpassed it was decided that a single span 165 ft. in clear width, or at least a series of spans without an intermediate support, would give the only really satisfactory solution. Even with this long span, it was necessary to use piers narrower than the supported roadway, which is 83 ft. 10 in. wide, in order to leave the intersection beneath unobstructed. The abutments were set back sufficiently far to clear all street lines.

The center suspended section and the two cantilevers give a total clear span of about 165 ft., or 170 ft. center to center of piers. Two anchor spans, of 80 ft. each, bring the total length center to center of end bearings to 330 ft. At the piers the roadway, which is considerably wider than the piers, is carried on two double cantilever arms. Owing to the extremely high bending moment in these members, they are double or of the "box" type. Had it been possible to use piers of a width equal to that of the abutments, the cost of the structure would have been greatly reduced and its erection likewise simplified.

Simplified Design

As the structure is statically determinate, the design was for the most part quite simple. From the accompanying sketches, Figs. 1 and 2, it will be noted that, except for the sway bracing which is composed of angles, the entire steel superstructure consists of plates and flats and is assembled solely by arc welding.

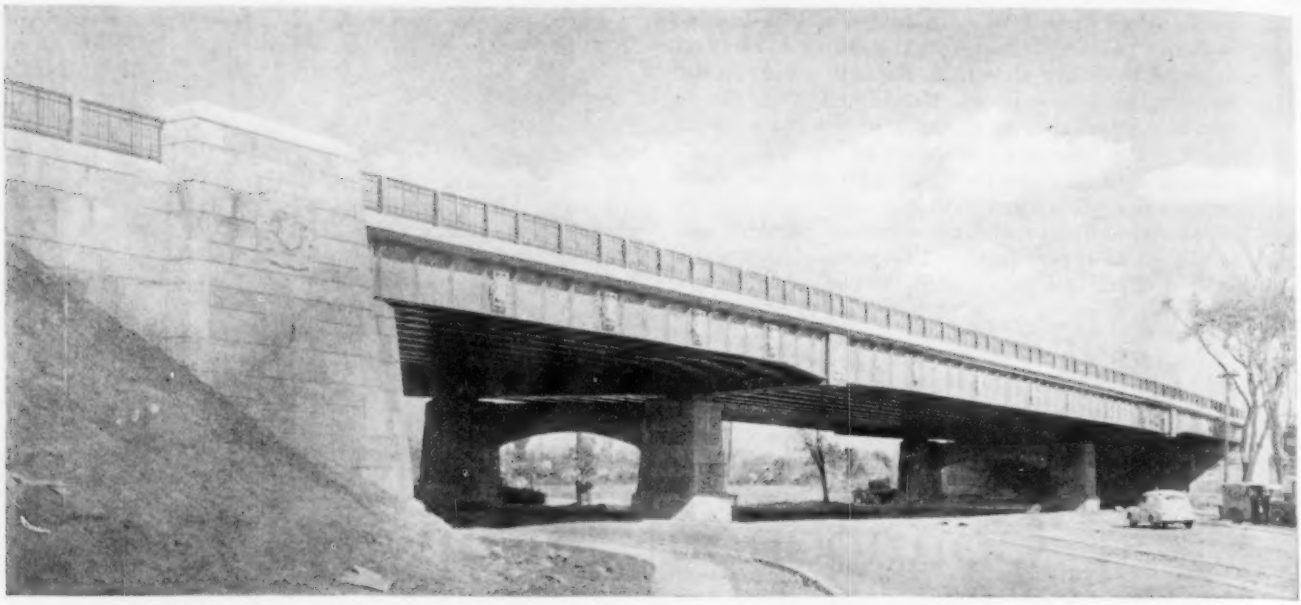
Three factors determined the depth of the suspended girders, clearance, grade and cost of right of way. A saving of metal would have been possible by increasing the depth of these girders, it is true, but certain underclearances had to be maintained and every foot the grade was raised added greatly to the cost. The approach side slopes are 1:2, which means that for every foot of height the width increases 4 ft., and acquisition of real estate was both difficult and expensive.



Link Connection Between Suspended Span and Cantilever Span. The 34 Connections Are Identical

* Unusual both in design and fabrication methods, this structure was under construction before the present priorities for steel went into effect. Over 12 miles of fillet welding was used, and it proved to be economical both of materials and of labor. Unit price data are also furnished by Mr. Willis in this article, a shortened form of a paper which was a prize winner in the latest competition of The James F. Lincoln Arc Welding Foundation. Reprinted from, September, 1943 *Civil Engineering*.

† Engineer of Bridge Design, Connecticut State Highway Dept., Hartford, Conn.



Jordan Lane Bridge, at Weathersfield, Conn. Medallions in Center Span Next to Piers Cover Connecting Links for the Suspended Girders

It may be of interest to give a list of the contract items and unit prices as bid by the contractor in May 1941:

Items	Unit	Quantity	Unit Price	Total
Clearing and grubbing	L.S.	....	....	$ 500.00
Bridge excavation*	Cu. yd.	4,400	$ 1.50	6,600.00
Stone for drains*	Tons	70	2.00	140.00
1/2-in. expansion joint	Sq. ft.	830	0.50	415.00
Deformed steel bars	Lb.	438,560	0.04	17,542.40
Structural steel*	Lb.	1,700,000	0.075	127,500.00
Metal bridge railing	Lin. ft.	800	12.00	9,600.00
Class A concrete*	Cu. yd.	4,280	14.00	59,920.00
Cast stone	L.S.	....	....	15,000.00
Cast-stone ornaments	Each	4	50.00	200.00
Cast-iron ornaments	L.S.	....	....	2,500.00
Copper flashing	Lb.	710	1.00	710.00
Portland cement	Bbl.	6,225	2.40	19,940.00
Total bid for contract items				$260,567.40
State's estimate for above items				261,599.50

* Items so marked were bid by contractor at the same unit price as was estimated by the state.

It was also highly desirable that the grade be kept low so as to minimize the amount of borrow required. There was little fill material in the vicinity; the haul was long and consequently expensive.

In the 120-ft. suspended span, all longitudinal girders excepting the one at the center are united to the roadway slab by reinforcing bars, welded to the top flanges of the steel girders. Thus horizontal shear between these elements is effectively developed. This converts the simple steel girder into a "composite" section, similar in its analysis and action to the concrete T-beam. The center girder was not tied into the slab in this manner for two reasons. It was necessary to allow for lateral expansion and, furthermore, the increased depth of girder possible under the center strip developed sufficient section to meet moment requirements.

The anchor spans are designed for two different conditions of loading. During construction it was specified that the concrete deck on each anchor span should be poured first. Also it was foreseen that much of the equipment used in the erection of the remainder of the

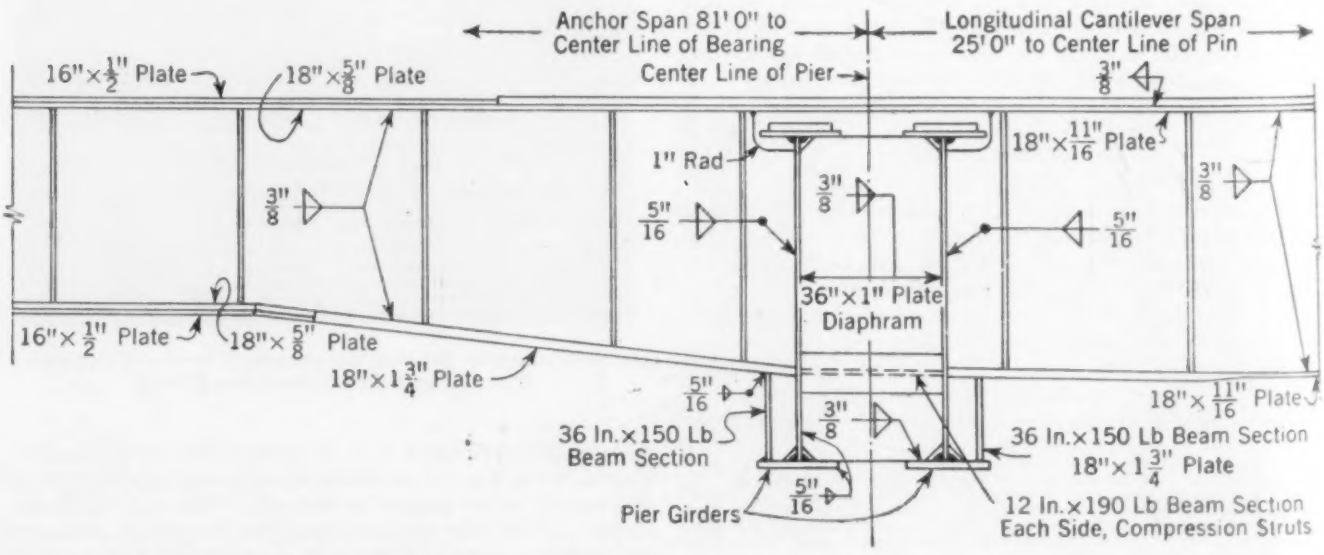


Fig. 1—Section through Pier Girder Showing Connection of One of the 17 Longitudinal Girders

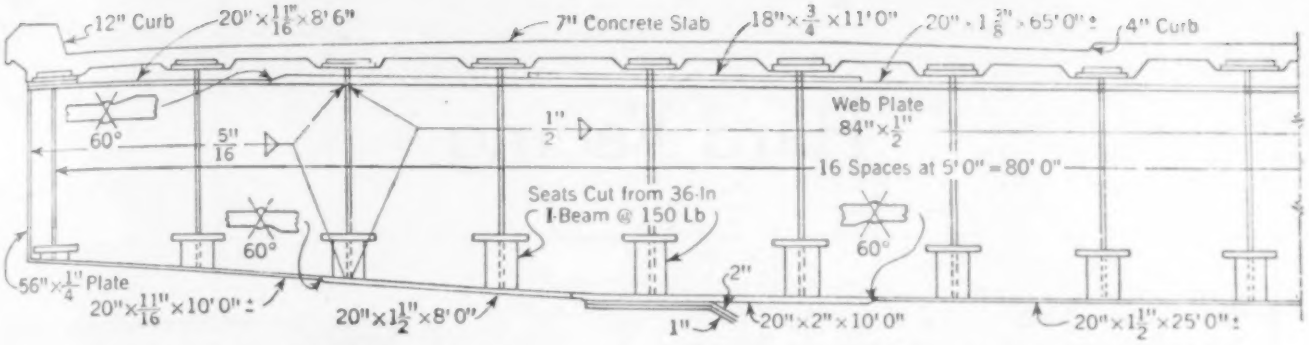


Fig. 2—Half Elevation of Pier Girder Showing Arrangement of Longitudinal Girders

bridge would be installed on this span. It was therefore deemed advisable to design it as a simple span, carrying the full dead and live loads subject to a slight reduction, because of the weight of the cantilever arms which created some negative moment.

Second Condition of Full Dead and Live Load

The second condition occurs after the bridge is completed and open to traffic. Then longitudinal cantilevers and suspended spans receive the full dead and live load, while dead load only is placed on the anchor span. The additional section in the anchor span necessary for the excess of negative over positive moments is provided by the extension of the heavy cover plates at and adjacent to the pier girders. At the point where the outer cover plate (16 x 1 1/8 in.) can be reduced but some additional flange area is still necessary, a smaller plate is added (16 x 1/2 in.) by butt welding to the heavier plate to maintain continuity. To augment the section at the butt joint, which is calculated to withstand a stress of 13,500 psi, two plates, 6 x 5/8 in., are welded under the upper joint and over the lower joint. It was only necessary to carry the extra cover plates to a point near the center of the span; from there to the abutment end the section is sufficient for the moments involved.

The specifications for this project require that whenever plates are to be spliced, this shall be done before assembly. Thus all spliced girder flanges are welded together before being welded to the girder webs, thereby reducing or eliminating stresses "locked up" due to shrinkage. However, field splices united longitudinal cantilevers with anchor girders.

While this bridge now occupies and practically covers all of what was once known as "Goodrich Square," there seems to be but little local opposition to it, principally because of its fine appearance. As far as the writer has been able to determine, it is the largest purely highway grade separation in New England, not only with regard to total span and width, but also in the matter of quantities of material, width of the area of intersecting streets on the lower level and the money involved.

There are 1,700,000 lb. of carbon structural steel in its makeup, and about 12 tons of welding rods or electrodes. The total length of all the fillet welds, if put end to end, would be something over 12 miles.

Welding proved to be readily adaptable to any and all conditions met during fabrication and erection. A change from continuous welding to intermittent welding on the top cover plates of the longitudinal girders over the transverse girders was made. A review of the design showed that this was possible and a saving was effected. This was also done at the extension cover plate on the top flange of the anchor span girders where there occurs a reversal of stress. An adjustment in price was effected as this was not figured in the original design and cost analysis.

It has always been the writer's firm opinion that welding could best be promoted by proof of its economical use. Some of the fillet sizes and amounts of welding called for in the case of this structure are in excess of those required to meet stress conditions, but this is because the bridge was designed under specifications which are unreasonably conservative, a condition which the writer is confident will soon be corrected. Despite this fact a careful estimate showed that a riveted design required 32% more steel and would have cost an additional $6660, more than the entire cost of field and office engineering.

The project was designed by the author, and fabricated and erected by the American Bridge Co., who were the subcontractors for the Mariani Construction Co., general contractors of New Haven, Conn. The structure was built for the Connecticut State Highway Department.

Practical Design of Welded Steel Structures

by H. M. Priest

An up-to-date book of 150 pages copiously illustrated with charts and photos giving practical design information and procedures for the design of welded steel structures. Price $1.00. Bound in cloth covers.

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Hard Facing*

By J. R. Spence†

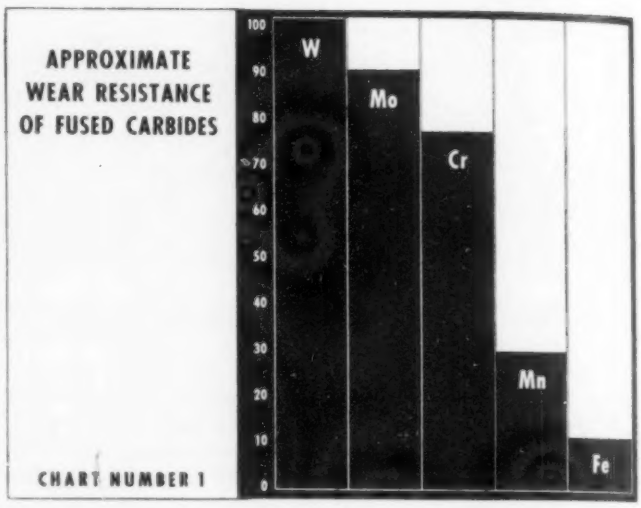
THE success of hard-facing in petroleum drilling operations, beginning as far back as 1925, has led to its use by many other industries. Internal combustion valves are now hard-faced by the manufacturer as are the tips of coal cutting bits, steel mill guides, mechanical loaders, mill hammers, muller plows, scraper blades and a diversity of other parts subjected to abrasive wear. In addition to being applied to various types of new equipment to insure long life and maximum operating efficiency, hard facing is also widely used in all types of industrial operations as a repair tool. Worn equipment, rebuilt to original shape and size through the use of the proper type of hard-facing alloy, invariably lasts longer than nonhard-faced factory replacements, thereby greatly reducing maintenance costs and increasing output.

Despite the widespread acceptance of hard facing, there are still thousands of industrial concerns which do not protect wearing surfaces of their equipment with these alloys. Perhaps the biggest reason is that there has been a definite lack of technical information available on hard-facing alloys and their functions. It is the purpose of this article to establish some pertinate facts concerning hard-facing materials and their properties and show why one type of hard-facing alloy may be superior to others for specific applications.

At the present time there are four common types of hard-facing materials, which include those containing less than 20% alloys, those containing more than 20% alloys, non-ferrous alloys and tungsten carbides. The hardness of the first three groups varies only 15 points on the Rockwell C scale, yet for a specific application one type of alloy may outlast the others by a ratio of as high as five to one. Obviously the slight difference in hardness would not account for the wide difference in service life, and it is necessary to look at properties other than hardness to determine which alloy should be selected for a given application.

The first three groups usually rely upon chrome as the essential wear-resistant ingredient. Why is chrome used rather than manganese, molybdenum or other alloys?

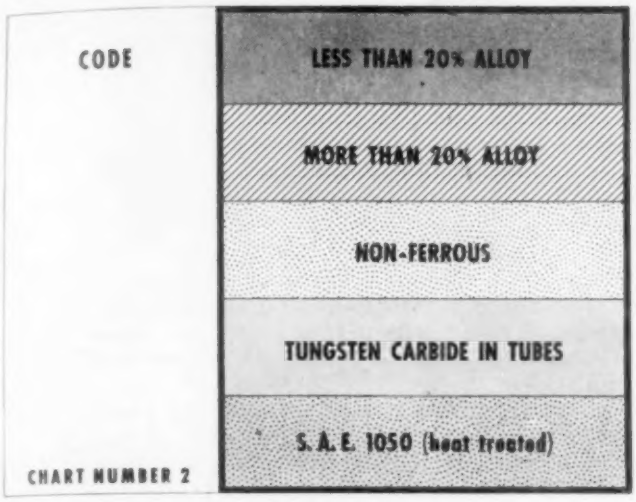
To begin with it is necessary to realize that most hard-facing materials are extremely high in carbon ranging from 1 to 4½%. The primary purpose of the carbon is to convert as much of the chromium into carbides as is possible and still maintain other desirable properties. Laboratory work and practical applications have proved the outstanding qualities of carbides from a wear-resistant viewpoint. In this connection it obviously becomes desirable to incorporate as much carbide as possible in any given type of alloy commensurate with other properties such as impact value, weldability and ease of manufacture. To explain in somewhat more detail the reason for the choice of chromium as the activating ingredient in most hard-facing alloys and the reason why tungsten carbide is the only known material adaptable as heterogeneous welding deposits, let us take a look at Chart No. 1.



Pertinent properties for consideration in the use of any of the carbides are as follows: wear resistance, ability to be welded, ability to alloy and still maintain the essence of carbide properties, ability to be manufactured in commercial quantities and ability to alloy in all proportions. Recognizing tungsten carbide as the peer of all metals and alloys in its resistance to abrasion and wear, we have conducted a number of tests indicating that the other carbides follow approximately the wear-resistant pattern indicated in the chart. It is to be remembered that these carbides have been produced by the simple melting together of the metal with sufficient carbon to produce the carbides. All tests have been made on melted and cast specimens. The results as indicated came from grinding tests as well as many practical applications. While these tests cannot be considered scientifically accurate they do bear out the values shown on the chart. In addition to the wear resistance indicated by the columns, the chart also indicates relative brittleness between the fused carbides. Tungsten carbide possesses the greatest ability to resist shock. Because of these properties and the weldability of the material itself it has become the standard alloy for hard-facing purposes provided it is used in rod form that will give a deposit composed essentially of fused tungsten carbide. This is accomplished by the production of the well-known tube tungsten carbide, which provides a deposit of a heterogeneous nature. In looking at the chart the question immediately arises—why tungsten carbide is not accepted as the basis of all homogeneous hard-facing rods. The answer to this may be found in the inability to produce a rod commercially that will maintain the tungsten in the carbide condition so as to impart at least in some degree the properties possessed by the pure tungsten carbide. The production of such an alloy is not possible due to the extreme solubility of tungsten carbide in molten metal baths.

Our next choice for the production of homogeneous

* Presented before the Detroit Section and Flint Division, A.W.S.
† General Sales Manager, Stoody Co., Whittier, Calif.



rods for high resistance to abrasion would be molybdenum carbides. This alloy possesses wear-resistant properties nearly comparable with tungsten carbide. Like tungsten carbide, however, it has high solubility and it is difficult to produce alloys which impart the properties of the pure carbide.

While chromium carbide is not so wear resistant as either molybdenum or tungsten carbide, it is easily welded, will alloy in all proportions and still maintain many of the carbide properties. It can be easily manufactured in commercial quantities and is vastly superior in wear resistance to manganese and iron carbides. It is for these reasons chromium is used in nearly all the homogeneous hard-facing rods as the essential wear-resistant ingredient.

Going back to the four groups of alloys let us take a look at their properties and their adaptability to specific types of applications. Chart No. 2 indicates the four groups of alloys. At the bottom of the chart, for comparative purposes, we have added S.A.E. 1050 steel in the heat-treated condition. This alloy was selected because so much equipment is made from this material. However, had we chosen any of the S.A.E. carbon or mild alloy steels the ratios as indicated by the charts to follow would be in approximately the same proportion to the hard-facing alloys as the S.A.E. 1050 steel.

Group 1

Alloys have a ferrous base and rely upon chromium to impart resistance to wear. Generally there are substantial additions of manganese and silicon. The aggregate alloys including chromium range from 7 to 15%. Alloys of this group are readily forgeable at high temperature, but cannot be cold worked in any manner. They are nonmachinable and possess the quality of acquiring a high polish. They are somewhat more resistant to corrosion than S.A.E. 1050 steel, but not sufficiently to be considered stainless in any sense of the term. At temperatures in excess of 500° F. they are subject to relatively rapid oxidation.

The hardness of these hard-facing products when deposited by either electric or acetylene process is approximately 50 Rockwell C—the same as S.A.E. 1050 heat-treated. These alloys, when subjected to wear, will last three times longer than S.A.E. 1050.

While supplied in various types both for electric and acetylene application, they are used mostly for hard-facing heavy equipment requiring the use of the electric method.

This group of alloys represent the hard-facing materials possessing greatest resistance to impact, but they cannot be considered as having impact values comparable with S.A.E. 1050.

Group 2 (More than 20% Alloys)

These alloys have as their wear-resistant base chromium which will vary from 18 to 35%. Considerable quantities of manganese, silicon, molybdenum, cobalt and vanadium may be incorporated to impart other desirable properties. Aggregate alloy percentages vary from 25 to 55%. One of their outstanding characteristics is their ability to polish in a high degree. They can be finished only by grinding and cannot be worked or forged at any temperature by any known means. Their resistance to wear is 10 to 15 times greater than S.A.E. 1050 steel. These alloys can be considered as stainless, having excellent resistance to corrosion when in contact with more common corrosive media. They cannot, however, be given consideration for application where corrosion is the prime factor.

The hardness of these alloys range from 55 to 62 Rockwell C. Because these alloys have a minimum of impact resistance, it is necessary to make sure they are adequately supported by the base metal. Rods in this group are available for electric and acetylene application. They cannot be heat treated.

Group 3

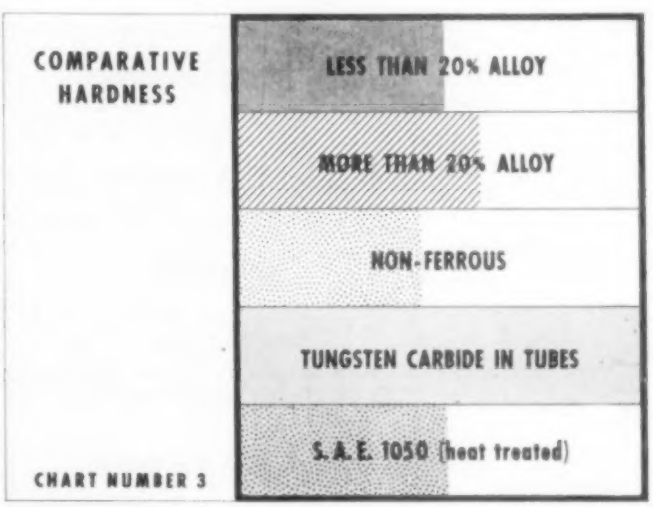
This group is represented by alloys containing little or no iron. Like other hard-facing materials they are high in chromium (ranging from 20 to 30%) from which they obtain their wear resistance.

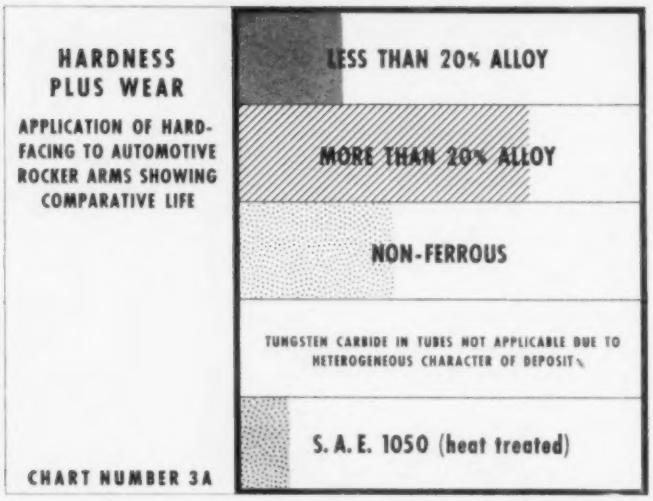
Because of their composition they possess corrosion resistance comparable and in some cases superior to stainless steels. They have outstanding resistance to oxidation, particularly at elevated temperatures.

Because of the multiplicity of application where heat or corrosion are involved, it has become desirable to produce these alloys in more than one type—the difference in properties being particularly noticeable in hardness and impact resistance. One alloy of this group has a Rockwell C hardness of 43 and is machinable with carbide tools. Another alloy has a Rockwell C hardness of 54 being nonmachinable.

The impact resistance of the lower hardness alloy is roughly comparable with the less than 20% alloy, while impact value of the harder alloys is about the same as those in Group 2 (over 20% alloy).

The wear resistance of nonferrous hard-facing materials is, generally speaking, 10 to 15 times greater than S.A.E. 1050 steels. These alloys have exceptional flow-




HARDNESS
PLUS WEAR
APPLICATION OF HARD-FACING TO AUTOMOTIVE ROCKER ARMS SHOWING COMPARATIVE LIFE
LESS THAN 20% ALLOY
MORE THAN 20% ALLOY
NON-FERROUS
TUNGSTEN CARBIDE IN TUBES NOT APPLICABLE DUE TO HETEROGENEOUS CHARACTER OF DEPOSIT
S. A. E. 1050 (heat treated)
CHART NUMBER 3A

ing qualities when applied by acetylene method, but are not so adaptable to electric application as those in Group 2.

Group 4 (Includes Tungsten Carbide Alloys)

In order to give an understanding of properties of heterogeneous tungsten carbide rods it is necessary to be acquainted with cast tungsten carbide. Tungsten carbide in the cast condition is the hardest known material which can be incorporated into a welding rod so as to give, when deposited, a heterogeneous material that will maintain all the properties of cast tungsten carbide.

Tungsten carbide is manufactured by the simple melting together of tungsten metal and carbon. The resulting alloy is cast into various shapes. This material has a hardness many times in excess of any of the other alloys mentioned. It is relatively brittle, having no impact value whatsoever. For this reason it is necessary, in order to use the material for welding purposes, to incorporate small tungsten carbide particles in tubes; thus imparting to the deposit some of the properties of the steel tubing and increasing the impact strength. The impact resistance of a tubed tungsten carbide deposit will be comparable with alloys in Group 2.

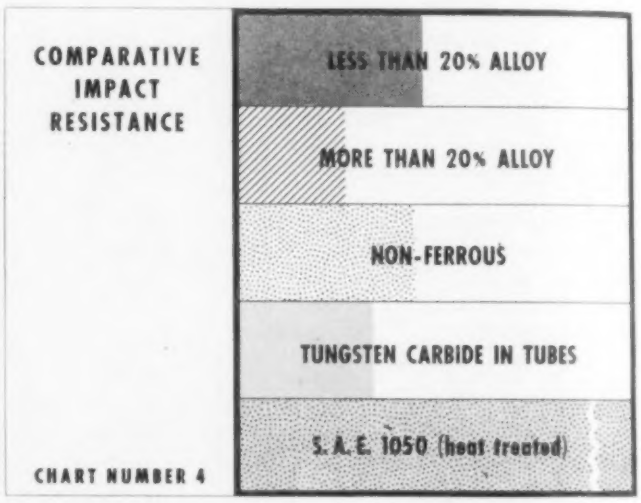
Tungsten carbide deposits can be heat treated, but are nonmachinable. Accurate finishing by grinding can be accomplished only by use of diamond wheels. These alloys have a very limited resistance to corrosion, and are particularly susceptible to oxidation at elevated temperatures.

Tube tungsten carbide deposits have a wear resistance of at least 30 to 1 over S.A.E. 1050 steel. Because of the necessary heterogeneous nature of deposits this group of alloys is not to be recommended for applications requiring a polish or a smooth wearing surface.

They are available for electric or acetylene application.

Since there are so many different analyses of rods in each group it would obviously be an impossibility to discuss all of them at this time. Consequently the four groups are represented by one specific alloy from each group. These alloys, incidentally, are those which cover the largest percentage of applications, are produced by a number of manufacturers and are made in the greatest volume. (As a matter of fact, these four types of alloys represent approximately 95% of all the hard-facing metals sold.)

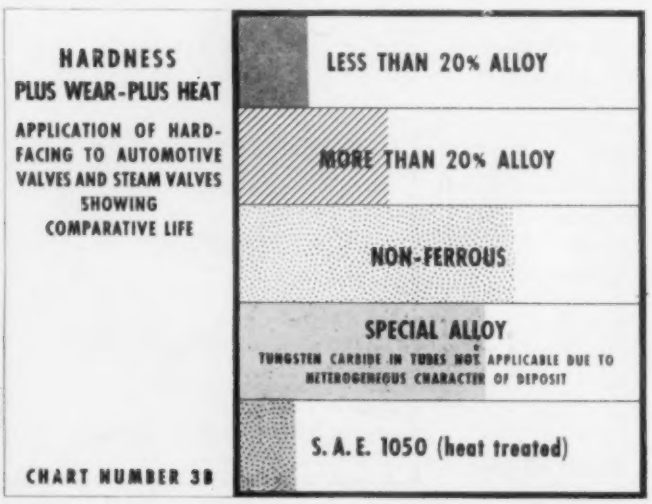
In selecting a hard-facing alloy for any given application there has been a decided tendency on the part of many individuals to place a great deal of importance on the hardness of the materials. In fact the hardness of various alloys has been emphasized to such an extent that the average individual seems to regard this factor as the ultimate in hard-facing metals. It is, of course, true that practically all hard-facing metals are of a hard type alloy, but it is also true that there are many alloys in common use which possess great hardness but which could not be termed hard-facing alloys by any stretch of the term. For example, let us take 1050 steel. This type of steel, in the heat-treated condition, is as hard as or harder than the majority of hard-facing metals. However, 1050 steel was not developed for wear resistance, and consequently does not contain the properties which are necessary for resistance to abrasion.

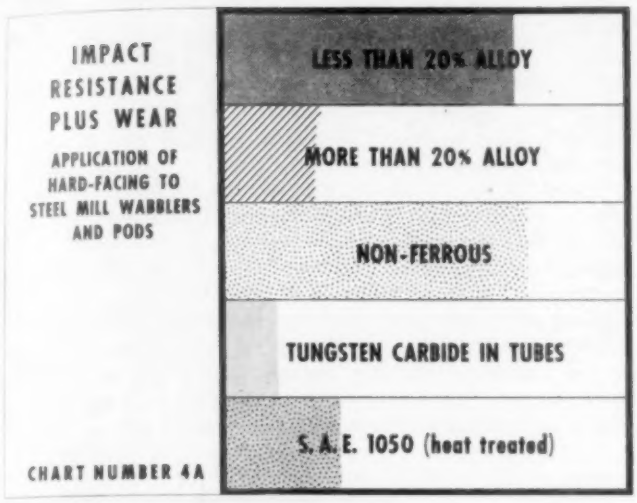


Generally speaking, the hardness of both heat-treated alloys and hard-facing alloys is spoken of in terms of Rockwell C and will vary according to the type of material.

In the development of alloy steels, which are to be used in their heat-treated condition, the factor of hardness and strength is of prime importance. These steels are, metallurgically speaking, designed to give maximum strength and maximum elongation at a maximum hardness. Steels of this nature are not made for wear-resistant purposes. In the development of hard-facing metals, the factor of most importance is the ability of the alloy to withstand severe abrasion or wear. The applications to which hard-facing alloys are put vary to such a large degree that it becomes imperative to combine properties other than wear resistance in their make-up.

Although it has been found that the wear resistance


HARDNESS
PLUS WEAR-PLUS HEAT
APPLICATION OF HARD-FACING TO AUTOMOTIVE VALVES AND STEAM VALVES SHOWING COMPARATIVE LIFE
LESS THAN 20% ALLOY
MORE THAN 20% ALLOY
NON-FERROUS
SPECIAL ALLOY
TUNGSTEN CARBIDE IN TUBES NOT APPLICABLE DUE TO HETEROGENEOUS CHARACTER OF DEPOSIT
S. A. E. 1050 (heat treated)
CHART NUMBER 3B


IMPACT RESISTANCE PLUS WEAR
APPLICATION OF HARD-FACING TO STEEL MILL WABBLERS AND PODS
LESS THAN 20% ALLOY
MORE THAN 20% ALLOY
NON-FERROUS
TUNGSTEN CARBIDE IN TUBES
S. A. E. 1050 (heat treated)
CHART NUMBER 4A

of 1050 steel increases with hardness, this particular property does not hold true with hard-facing alloys. While every attempt is made to maintain a constant hardness for various types of hard-facing products, the particular hardness of any one metal is controlled by the type of alloy of which it is composed. In other words, the hardness of any hard-facing material is an indirect property, resulting from the attainment of the desirable amount of wear resistance in combination with other properties essential to the alloy for a particular application. The wear resistance of any alloy depends not only on the amount of alloying element or elements contained in the steel, but also depends more particularly upon the amount of chromium which it contains. Alloy steels of the so-called mild type, with an aggregate of 3 to 6% alloying material as well as high speed and stainless steels containing as much as 25 to 30% alloying materials, have a certain definite amount of wear resistance as compared to mild steel, regardless of whether or not they are in the hardened condition. The wear resistance of these steels will increase by heat treating in approximately the same ratio as 1050 steel which has been subjected to heat treatment. Heat treatment of 1050 or alloy steels often raises the hardness from 10 Rockwell C to 65 Rockwell C. The increase in wear resistance, due to the increase in hardness, in some cases may double the life of the part. Assuming the life of the part to be double when the part has been heat treated to a Rockwell C 65, it is possible by the use of a hard-facing material having a lower Rockwell hardness to increase the life of this heat-treated part many times.

Hardness in connection with the selection of hard-facing metals is of no importance. The real purpose of hard facing is to retard wear. Consequently, in the selection of the proper type of hard-facing metal, the question is: "Which one will wear longest?"—not "Which one is the hardest?" Taking into consideration other factors such as heat, the question of which one will wear the greater length of time is naturally much more important than the hardness of the hard-facing alloy used. If the hardness were the deciding factor in facing metals, then it would only be necessary to obtain a steel which could be heat treated. It would then be possible not only to secure the same hardness as obtained by hard facing, but to secure a hardness in excess of homogeneous hard-facing materials. Such practice would, however, give only additional hardness and not to any extent additional wear or abrasion resistance.

Chart No. 3 shows the relative hardness of the various groups of alloys under discussion. If the selection of hard-facing materials for automotive rocker arms were to be made on the basis of hardness, it is obvious that the choice would be tungsten carbide in tubes and there would be little or no difference in life expectancy between the other four alloys. As we have already said, hardness is of no importance in the selection of hard-facing materials for any application. This can be illustrated by Chart No. 3A showing the use of the hardest material (tungsten carbide in tubes) for this application is not practical, due to its heterogeneous character. Also, to be considered is the fact that in spite of approximately the same hardness existing between the other four alloys the life expectancy has changed materially in favor of the hard-facing alloys over the S.A.E. 1050.

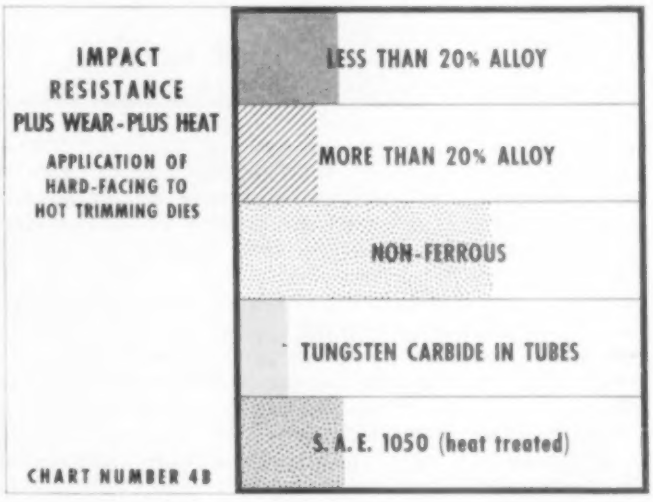
Assuming the life of the heat-treated S.A.E. 1050 rocker arm to be 150 hr. without the necessity of adjustment the hours obtained from the less than 20% alloy would be 325, from the more than 20% alloy 950 and from nonferrous 500.

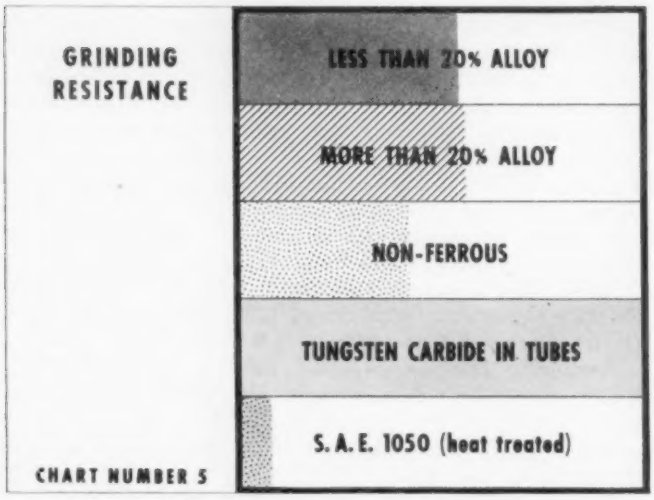
It therefore becomes obvious that the more than 20% alloy group possesses outstanding properties necessary for this application by virtue of its ability to polish, resist galling and withstand severe frictional wear.

Another illustration showing the fallacy of attaching too much importance to hardness is indicated by Chart No. 3B. Here again, because of the heterogeneous nature of tungsten carbide, it is not applicable. And, our choice is obviously the Group 3 or nonferrous material. This is true because this group of alloys possesses the ability to withstand heat and corrosion in conbination with wear. The success of this application can be emphasized by considering the life of a heat-treated 1050 valve at 2 weeks—the less than 20% alloy at 6 weeks—the more than 20% alloy at 12 weeks—and the nonferrous alloy at 20 weeks.

The special alloy illustrated in the chart rightfully belongs in Group 2 according to analysis. However, it is not one of the four specific hard-facing alloys upon which the charts are based. It is shown here because it is one of the recent developments in the hard-facing industry for valve applications, possessing the required properties in approximately the same amount as the nonferrous group and having the advantage of application by the electric method. Special alloys of this nature have been developed in the past for specific applications and, even though they represent a very small percentage of the total hard-facing volume, are none the less very important.

Chart No. 4 illustrates the comparative impact resistance of the various alloys. Unlike the property of hardness, this property is one of the prime factors in the selection of the proper hard-facing material for any given application.

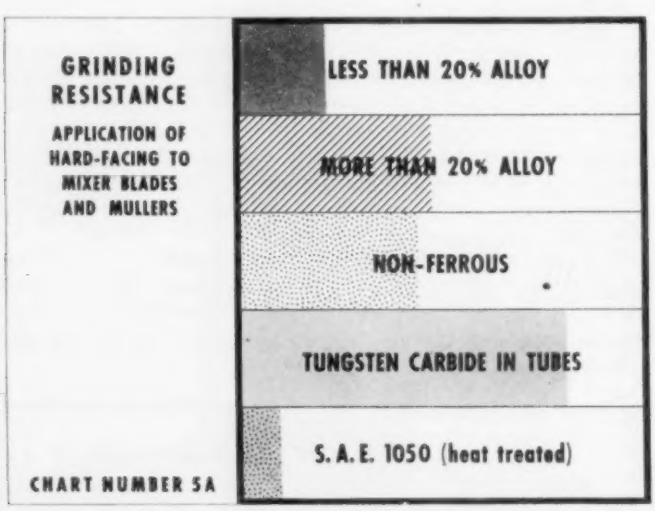

IMPACT RESISTANCE PLUS WEAR-PLUS HEAT
APPLICATION OF HARD-FACING TO HOT TRIMMING DIES
LESS THAN 20% ALLOY
MORE THAN 20% ALLOY
NON-FERROUS
TUNGSTEN CARBIDE IN TUBES
S. A. E. 1050 (heat treated)
CHART NUMBER 4B



It will be noticed that the 1050 steel possesses far greater impact resistance than any of the hard-facing materials and that it had a hardness comparable with groups 1, 2 and 3. It could therefore be expected to give service greater than any of these three groups of hard-facing materials if life expectancy could be based entirely upon hardness and impact resistance.

The application of hard-facing materials to steel mill roll wabblers represents an application in which impact resistance is of prime importance. Chart No. 4A shows the results that will be obtained through the use of the various alloys.

It will be noticed that in spite of the hardness and impact resistance of the S.A.E. 1050 steel, its value when used on roll wabblers is minor as compared either to the nonferrous or the less than 20% alloy.


GRINDING RESISTANCE
APPLICATION OF HARD-FACING TO MIXER BLADES AND MULLERS
LESS THAN 20% ALLOY
MORE THAN 20% ALLOY
NON-FERROUS
TUNGSTEN CARBIDE IN TUBES
S. A. E. 1050 (heat treated)
CHART NUMBER 5A

For practical purposes the tungsten carbide in tubes may be eliminated, owing principally to its relative brittleness compared with the nonferrous or less than 20% group The more than 20% alloy group may be eliminated for the same reason.

The choice obviously falls between the less than 20% and the nonferrous groups. The selection between the two is simplified by the fact that the cost of the less than 20% alloy is roughly one-sixth that of the nonferrous and the fact that the less than 20% alloy group can be applied by the electric method.

Hot-trimming dies represent another application where impact resistance is of prime importance. In addition to impact, however, we have the added factor of heat. Chart No. 4B represents the results which will be obtained through the use of the various alloys. While the foregoing chart showed the less than 20% alloy to be equal to the nonferrous group, the nonferrous alloy in this case is far superior because of its greater resistance to heat.

Hard facing is used primarily to extend the service life of equipment. This is accomplished by the use of alloys having exceptional resistance to wear. Consequently, any method that will determine the resistance to abrasion of these alloys is of great importance, and the results obtained form perhaps the most vital basis for selection of hard-facing materials. Resistance to grinding is a method whereby various alloys may be cataloged in a more or less accurate manner so as to indicate their relative resistance to certain types of wear.

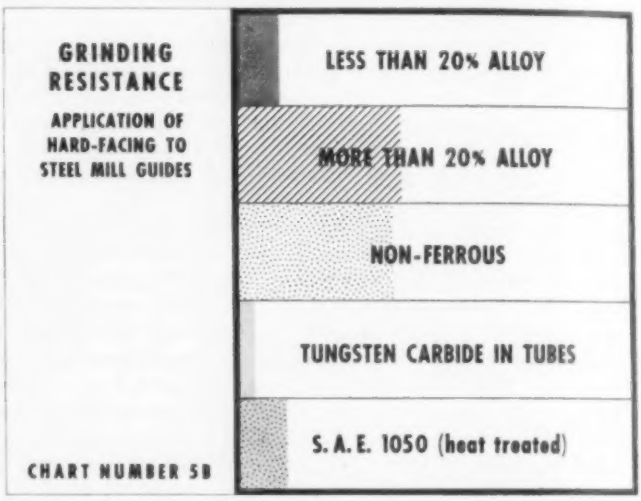


Chart No. 5 illustrates the comparative grinding resistance of the metals which have been the subject of this talk. Here again it will be found that S.A.E. 1050 has an insignificant value because of its low resistance to wear. There are certain types of applications for hard-facing materials in which the life expectancy will follow almost the exact pattern of Chart No. 5, such an application being the hard facing of mixer or muller blades.

The results of this application will be seen in Chart No. 5A. How closely these results parallel those of the grinding resistance results may be seen by a comparison with Chart No. 5.

While tungsten carbide offers superior resistance to grinding, its heterogeneous structure precludes its use for all applications where severe wear is encountered. At the same time other hard-facing alloys which may be used for comparative tests will bear out the general pattern obtained through grinding resistant tests. Such an application is the hard facing of steel mill guides shown on Chart No. 5B. Of particular interest here is the fact that the tungsten carbide application is of low value, actually giving less service than S.A.E. 1050 steel or the common alloys generally used for this purpose.

Those of you who have had unfortunate experiences with hard-facing applications may have found a few of the reasons in the foregoing discussion and from the charts. Any metal part subjected to abrasive wear can be made to give maximum service life through the application of the proper hard-facing alloy, but the selection of the correct rod is sometimes a little complicated. It usually saves time and money to contact one of several hard metal manufacturers.

The Welding of Copper Alloys*

By C. E. Swift†

A DISCUSSION of the welding of copper and copper alloys involves a combination of the newest of all metal-fabricating processes with the oldest of metals. Welding broke out of obscurity during World War I and since then has become such a vital factor in the joining of metal that modern metal working has been designed around it. Most of the publicized progress in welding has been in the field of iron and its many alloys. As we are in the "iron age," this is not surprising. However, copper and its alloys are used extensively, though perhaps not as spectacularly as iron, so a study of the welding of this ancient metal and its alloys may be of interest.

Before the welding procedures and welding rods for use with copper alloys are described, it would be well to point out the fundamental characteristics of these metals that affect their weldability.

Wrought Copper

Electrolytic Copper

There are two kinds of copper that should be of interest to the welder and coppersmith. The ordinary copper sheet delivered to the shop for forming and welding or brazing is "oxygen-bearing, tough-pitch copper" or more commonly known as "electrolytic copper." It contains 0.03 to 0.07% oxygen in the form of cuprous oxide specks distributed uniformly throughout the metal. This cuprous oxide has the beneficial effect of reducing the grain size of the metal and does not adversely affect the general properties of the cold wrought metal. But, when this copper sheet is heated above 1500° F., as is necessary for brazing with bronze or for welding, two weakening effects are caused by the curpous oxide. If this or a higher temperature is maintained for more than 3 or 4 sec., the cuprous oxide collects at the grain boundaries and reduces the strength of the cold metal from about 30,000 psi. to 21,000 psi. And further, if this temperature is obtained in the presence of a reducing gas, such as under the excess-acetylene flame of an oxyacetylene welding torch, the free hydrogen will actually penetrate the hot solid copper and "reduce" the cuprous oxide to form water vapor and copper. As the water vapor cannot escape, it causes a microscopic porosity that weakens the copper to a strength as low as 12,000 psi.

However, each of these bad effects of cuprous oxide can be corrected by "cold working" or hammering the metal, followed by annealing below this critical temperature. These troubles can be completely avoided, of course, by brazing electrolytic copper with the lower melting point silver-brazing alloys at temperatures below 1500° F. and always using a strongly oxidizing flame when heating copper above this temperature. This last cannot be emphasized too strongly. Considering these properties of electrolytic copper, it is concluded that it may be brazed with brass or bronze or welded with copper rods, if it is to be subsequently hammered or otherwise cold worked. If it is not to be further cold worked, then electrolytic copper should only be silver brazed or soft soldered.

There is one exception to these rules: electrolytic copper is successfully carbon arc welded, without preheating, using a long (40 to 60 v.) arc to obtain a neutral atmosphere in the arc flame and using a phosphor bronze filler rod. This is possible because a high welding current is used and the welding speed is so fast that the cuprous oxide does not have time to move to the grain boundaries. The process is limited, however, to downhand welding on properly backed-up joints.

Deoxidized Copper

The other kind of copper is "deoxidized" copper. It is commonly furnished in all copper tubing but can also be obtained in sheets and plates at a slightly higher cost than electrolytic copper. This copper is usually deoxidized with phosphorus and may still contain up to 0.05% phosphorus in its final form. Its heat conductivity will be about 70% that of electrolytic copper which is of some help when brazing, welding or working it. This metal may be brazed with brass or welded with copper or bronze rods and, as no cuprous oxide is present, the strength of the annealed sheet or plate will be developed without working or hammering the metal. In all respects, it is definitely superior to electrolytic copper, if it is to be brazed, welded or extensively hot worked.

When heating either electrolytic or deoxidized copper for silver brazing, welding or forming, care must be taken to keep lead, tin or soft solders off the copper plates or sheets. At these high temperatures, the lower melting point metals mentioned will penetrate or surface alloy with the copper and cause rapid deterioration of the area. This may result in actually "eating" holes through the copper or show up as cracks when the copper is worked.

Wrought Copper Alloys

There are hundreds of alloys of copper in common use today, but relatively few of them are used in applications requiring welding. Many of them are soldered or silver brazed, which is done at temperatures below which the alloys are affected, other than being annealed or softened. It is of most interest, then, to mention those alloys that are occasionally encountered in welding applications. We will first discuss the wrought metals, those that are furnished as rolled sheets or plates or in drawn tubes.

Before mentioning specific alloys, it would be well to become familiar with one characteristic of these metals that should always be kept in mind when brazing, welding or working them. Almost without exception, the copper alloys are "hot-short." "Hot-short" means that, at temperatures below the apparent solidification of the metal, small amounts of lower melting point constituents or phases are still liquid and surround the grains of metal. Inasmuch as these constituents are liquid, they impart no strength to the metal while in that temperature range and

* Presented at the October 28th Meeting, Puget Sound Section, A.W.S.
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the metal cannot be stressed or worked in any way until these constituents solidify. The safe working temperatures of the copper alloys, then, are usually 200 to 400° F. below their melting points. Only electrolytic and deoxidized copper and certain of the aluminum bronzes seem to be free from the "curse" of "hot-shortness."

No information will be given here on the physical properties of the alloys discussed, because these data are readily available in tables furnished by the manufacturers of these metals, or in publications of various technical societies. Such tables will also include the exact compositions of these alloys which vary slightly from one manufacturer to another.

Wrought Brass

Low Zinc Brasses

Brass is technically an alloy of copper and zinc. However, in the development of alloys over the years, varying amounts of other metals have been added to copper and zinc to develop certain desired properties. From a welding and metal-working standpoint, all those alloys containing more than 15% zinc act much the same, so they will be considered under the heading of brass, although many of them are commonly referred to as "bronzes." Commercial bronze is the first brass in this instance—it is an alloy of 90% copper and 10% zinc, used for architectural work because of its bronze color. It is most often gas welded with a rod of its own composition, as good color match in the weld metal is of first importance. Red brass is an alloy of 15 or 20% zinc, the balance copper, and was widely used as pipe for domestic or commercial applications. The use of thin-walled copper tubing and soldered fittings, though, has practically eliminated the use of red brass pipe and screwed fittings for domestic work. These alloys can be gas welded with rods of similar composition, the high zinc bronze gas-welding rods, or arc welded with phosphorus, silicon or aluminum bronze.

Common Brass

Common brass, 35% zinc and 65% copper, is, as its name signifies, the most common copper zinc alloy. It is not often welded, however, as it is usually soft soldered or silver brazed. It is gas welded with the common, so-called "bronze," gas-welding rods. In heavy sections, it can be arc welded with aluminum bronze or silicon bronze.

Naval Brass

Naval brass or "Tobin Bronze" is an alloy of 39% zinc, 0.75% tin, possibly 0.25% lead and the balance copper. This being the first mention of lead in the copper alloys, it might be well to point out that, as far as welding properties are concerned, it is the most undesirable element to have present. It does not alloy with the other metals, but remains as free lead and may be seen "sweating" out of high lead alloys on the application of heat. It does not readily volatilize or burn away, but gathers as an objectionable oxide on the surface of the metal being welded. In short, avoid *welding* any copper alloys containing lead—braze them at the lowest possible temperatures. As might be assumed, Tobin Bronze or naval brass welding rods would contain no lead whatever. Lead would only be present in these alloys to improve their machining properties. These metals would be welded the same as common brass.

Muntz Metal

Muntz metal is 40% zinc and 60% copper. It is most commonly used in heavy plates for heat exchanger tube sheets and in condenser tubing. Occasionally it is necessary to weld two sections of Muntz metal to form a large tube sheet. It can be done by gas welding with "Bronze" gas-welding rods or arc welding with aluminum bronze. Arc welding with aluminum bronze has not been common practice, but recent tests indicate that it is feasible.

Architectural Bronze

Architectural Bronze, really a brass, contains 41.5% zinc, 2.5% lead and the balance copper. This metal is available largely in extruded shapes and the lead is added to improve its extruding properties as well as to add to its coloring. Because of its high lead content, it is difficult to weld, but sound welds can be accomplished by using "Bronze" gas-welding rods applied with a strongly oxidizing flame. This strongly oxidizing flame quickly builds up a film of lead and zinc oxide which retards further oxidation and makes possible sound welds. Ordinary brazing fluxes are used generously when making such welds.

Wrought Bronze

Tin Bronzes

The true bronzes are alloys of copper and tin. In the wrought metals the tin never exceeds 10.5%, but it is always accompanied by a deoxidizer which is usually phosphorus, in quantity up to 0.1%. These alloys, varying in tin content from 1.25 to 10.5%, are referred to as phosphor bronzes. They are believed to be the oldest alloys of copper. There are welding rods available in the same alloys as the plates, though the rods carry up to 0.25% phosphorus to allow for the loss of phosphorus during welding. The high-phosphorus rods are used for arc welding and the low-phosphorus rods for gas welding. No fluxes are required for welding these alloys as the phosphorus acts in this capacity.

Silicon Bronze

In recent years a number of special bronzes are finding increasing use. The silicon bronzes, known by a variety of trade names, are essentially 94 to 96% copper, 3 to 4% silicon and the balance a third element which may be manganese, iron, zinc, or tin, depending on the manufacturer. Because of the low heat conductivity of these metals and the strong deoxidizing action of the silicon, they are one of the most weldable of all the copper alloys. With suitable fluxes, these metals are readily welded by the oxyacetylene torch or by either metallic or carbon arc. The arc-welding flux, applied dry or mixed in dry alcohol, is 90% fused borax and 10% sodium fluoride.

Aluminum Bronze

Alloys of copper and aluminum are becoming more widely used as industry becomes familiar with their many desirable properties. Along with their wide range of strength and hardness and good bearing properties, they are the least hot-short of all the copper alloys. To develop certain desirable properties various manufacturers have added small amounts of three or four other metals, such as iron, nickel, manganese and tin. Because of the high percentage of aluminum which oxidizes readily, gas welding of aluminum bronze is difficult. Therefore, these alloys are usually welded with coated electrodes used either for metallic or carbon arc welding.

Copper-Nickel Alloys

Cupro-nickel or copper-nickel is an alloy of copper and nickel and is widely used in marine work because of its

excellent resistance to salt water corrosion. It is an alloy containing 30% nickel and the balance copper. Gas-welding rods and fluxes and coated electrodes are available in this alloy. Copper-nickel alloys are also made containing 15 and 20% nickel. Copper-nickel alloys are very hot-short, like most of the other alloys of copper, so extreme care must be taken when hot working or welding them to avoid cracking the metal. To avoid cracking, work it as cold as possible and weld it as quickly as possible. In short, never stress it while above 1600° F. This should be kept in mind even when silver brazing, as intergranular penetration of the silver-brazing alloy into the copper-nickel will occur if the copper-nickel is under much tensile stress when the brazing is done. This will result in cracks through the base metal at the edge of the braze. These cracks may not be evident at the time of brazing, but will show up later if the metal is bent a few times or severely worked.

Castings

Many of the alloys of wrought copper are available, with slight variations, as cast metals. If these variations are not represented by an increase in their lead content, there would be no change in their welding properties. However, most of the common brass or bronze castings contain from 1.0 to 5.0% lead. This is added to improve the fluidity of the molten bronze so that thin sections can be poured, or to improve the machinability of the casting. It also incidentally helps to make sound castings as the lead, not alloying with the other metals present, tends to fill voids that might occur. In addition to the difficulties that may be encountered from lead oxide when welding these metals, lead increases the tendency of the metal to hot-short failures.

Hydraulic Bronze or 85-5-5-5-

The most common of all the cast bronzes is hydraulic bronze, often referred to as "85 and three fives" because it contains 5% each of tin, zinc and lead, with the balance copper. This high lead content makes it extremely difficult to weld. Whenever possible, this metal should be brazed with low-temperature alloys. Welding should be avoided. If welding is imperative, thin sections should be gas welded after very careful preheating, using a strongly oxidizing oxyacetylene flame and any common bronze gas-welding rods with ordinary brazing fluxes. Heavy sections can be arc welded without preheating using the carbon arc with a silicon bronze or coated aluminum bronze filler rod. Care must be taken to carry the arc on the weld metal.

Navy Compositions "M" and "G"

Navy Composition "M" bronze is an alloy of 91% copper, 6% tin, 2% zinc and 1% lead. Because of the low lead and zinc content, this alloy is readily arc welded with bare or coated phosphor bronze rods by either carbon or metallic arc. Navy Composition "G" is an alloy of 88% copper, 9% tin and 3% zinc. It is also known as "Gun Metal." It is readily welded as mentioned above for Composition "M."

Manganese Bronze

Manganese bronze is really a strengthened brass, as it contains from 25 to 39% zinc. Depending on the strength and hardness required in the manganese bonze, it may contain from 1.5 to 2.5% manganese, 0.75 to 6% aluminum, 0.75 to 4% iron, 25 to 39% zinc and the balance copper. Thin sections are easily gas welded with the regular bronze gas-welding rods. Heavy sections, such as ship propellers, can be arc welded with coated aluminum bronze electrodes to avoid the extensive preheating that would be required. When arc-welding it is important that the arc be carried on the weld metal to avoid burning zinc out of the base metal.

Bearing Bronze

The cast bearing bronzes carry up to 24% lead. Once the lead content passes 5%, it is almost impossible to weld the alloy. Fair results may be obtained using atomic-hydrogen or a carbon-arc-torch with low-phosphorous tin-bronze rods, but even with these special purpose torches, some porosity will be obtained.

Welding Rods

The welding rods made from copper alloys are, for the most part, very similar in composition to the wrought metals previously discussed. Minor variations are necessary, of course, to improve their welding properties, such as increasing the phosphorus content in the phosphor bronzes to allow for the phosphorus burned out during welding. And, of course, lead is always kept to an absolute minimum, except in those very rare instances where it is intentionally included. About the only place lead would be tolerated in weld metal is where the rod is being used to overlay bearing surfaces.

Copper

Electrolytic copper is seldom used as a welding rod, except where maximum electrical conductivity in the weld metal is required. When used for gas welding, a slightly oxidizing flame will reduce gassing of the weld metal. If any strength is required of the deposited metal, it should be well peened, either hot or cold.

Phosphorus deoxidized copper is used as a welding rod where pure copper is needed in the weld metal, but it is sluggish under the gas flame and does not contain enough phosphorus to be satisfactory for use with the carbon arc. Silicon deoxidized copper is also available as a copper welding rod and is entirely satisfactory for use on phosphorus deoxidized copper sheets and plates. A copper silicon alloy gas-welding flux is recommended. The silicon glass formed over the weld metal when using this rod is very helpful in preventing oxidation or gassing of the copper.

Phosphor Bronze

The phosphor bronzes are available in four or five different alloys—some for gas welding and some for arc welding. In general the same rod is not recommended for both welding processes. The gas-welding rods contain low phosphorus, seldom more than 0.05%, because more phosphorus builds up a heavy oxide on the surface of the weld which may become trapped in the weld metal. The arc-welding rods contain about 0.25% phosphorus. This higher phosphorus is needed to stand the higher temperatures of the arc weld and compensate for the greater phosphorus losses.

In most applications, the low tin (1.25%) and the low silver (1%) phosphor bronze rods are accepted as "copper" rods and are used mostly for gas welding copper. One of these rods is coated for use as a metallic arc electrode, but such high preheats are required for its successful application that it offers little advantage over gas welding. The 4% tin (Phos. Br. "A") and the 10.5% tin (Phos. Br. "D") are most commonly used as filler rods for carbon arc welding or coated for metallic arc welding. The 8% tin phosphor bronze ("C") is available as a coated rod or, with low phosphorus content,

for gas welding. These rods are used for arc welding copper, by either the "long carbon arc" or metallic arc, for welding other bronzes and for overlays on steel or cast iron for bearing surfaces.

Bronze Gas-Welding Rods

The "bronze" gas-welding rods, really brasses, are all much the same in composition. Naval brass or Tobin Bronze has been described before. It was one of the first alloys to be used for bronze welding or brazing. Bronze will braze almost any metal that has a melting point higher than its own, except aluminum bronze. It has been extensively used for brazing broken cast iron and for joining dissimilar metals. Its use on steel should be watched, as it will penetrate and crack steel that is under tensile stress at the brazing temperature. Under certain conditions these cracks may extend completely through the part being brazed. Today, there are many variations of this type of bronze known as manganese bronze and by numerous trade names. The manufacturers claim such features as higher strength, greater hardness or less fuming during the welding operation. But their field of application is the same.

Silicon Bronze

Silicon bronze-welding rods are made in substantially the same alloys as are the rolled plates and tubes. Besides being suitable for welding the silicon bronze base metals, they are particularly good for various "carbon arc brazing" jobs. With very low current on the carbon electrode and using a very short arc, galvanized iron can be brazed without completely destroying the zinc coating. This type of braze will develop the full strength of the galvanized iron and will cause much less distortion in thin sheets than metallic arc welding with steel, not to mention doing much less damage to the galvanizing. Silicon bronze rods with a flux composed of 90% fused borax and 10% sodium fluoride can be used for carbon arc welding or brazing deoxidized copper, steel, brass and bronze. The principal requirement for success in such applications is to have the work clean, weld quickly and use a very short arc.

Aluminum Bronze

Aluminum bronze is not very satisfactory for gas welding. But excellent results are being obtained by either metallic arc or carbon arc welding using flux-coated electrodes or applying flux to the work and carbon arc welding. Besides welding aluminum bronze base metals with these rods and electrodes, they are used extensively in the harder grades for bearing overlays. Hardnesses up to 300 Brinell are obtained in these deposits. The softer and more ductile aluminum bronze is used for arc welding copper-zinc alloys. Aluminum bronze will easily match the strength of the common cast manganese bronze, such as used in ship propellers. It provides an excellent means of arc welding these heavy castings with little or no preheating being necessary. Further, the aluminum bronze with its yellowish color makes a good color match with the manganese bronze. Tests indicate that the aluminum bronze weld metal has the same potential as the cast manganese bronze so that little or no electrolytic corrosion will take place between the metals when they are in salt water. Aluminum bronze electrodes are excellent for metallic arc "brazing" malleable cast iron, clean grey iron, steel, brass and bronze or any combination of these metals.

Copper-Nickel

Cupro-nickel gas-welding rods and coated electrodes were developed for welding cupro-nickel sheets and plates. There are few other applications for them, though it has been shown that metallic arc welds on clean cast iron will be machinable through the fusion zone, providing the arc is maintained on the weld metal and not on the cast iron. When gas or arc welding cupro nickel, care must be taken to avoid stressing the weld metal or adjacent plate before it cools below the hot-short temperature range. This is done by observing the usual precautions when welding all metals of this type. Straight butt joints should be left open at one end and allowed to pull together as welding progresses. If a butt joint must be tacked, then start the weld in the center and work toward each end. Openings in vessels should be flared out to provide flexibility when fittings are attached. Make narrow, rapid welds.

Low-Temperature Brazing

No discussion of the welding, brazing or fabricating of copper alloys can be complete without at least mentioning the silver-brazing alloys which are of such tremendous value in this work. Some of them are really copper alloys, such as the phosphor-coppers, the low silver-content silver solders and Sil-Fos, a copper-silver-phosphorus alloy. Their use is recommended, almost without reservation, wherever lap joints can be used on joining thin-walled tubing in any copper alloy and for use on lap joints in copper in practically all instances. The advantages of using these silver-brazing alloys are many, but the outstanding advantage is that permanent pressure tight joints can be made without heating the hot-short copper alloys to their hot-short temperature range. It is a happy coincidence that the two copper alloys most difficult to braze, the silicon and aluminum bronzes, are the easiest to weld, so it is not often that difficulties are encountered for this reason.

When silver brazing copper alloys, it is well to keep in mind that, if the base metal is under tensile stress at the time the brazing metals are applied, there is danger of the brazing metal penetrating the copper alloy and causing cracking. If the parts being brazed are free from tensile stress or under compression, there is little danger of this occurring.

GUIDE TO WELDABILITY OF STEELS

A System of Determining the Effect of Welding Procedure Upon the Ductility of the Heated Zone Adjacent to the Weld in Plain Carbon and Alloy Steels.

BOOK OF 90 PAGES *PRICE $1.00*

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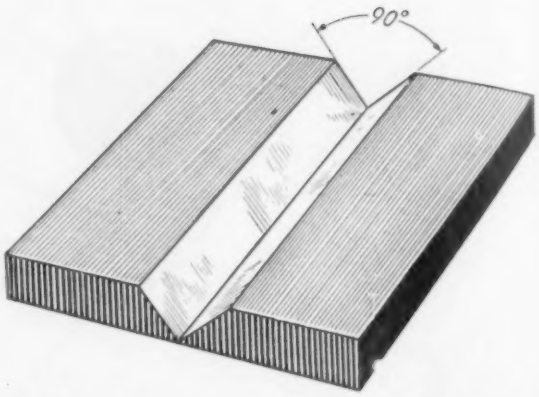
BELL TELEPHONE SYSTEM

A Review of Bronze Welding

By H. R. Morrison*

PRACTICALLY every oxyacetylene welding operator has had occasion to use bronze welding or bronze surfacing at one time or another. However, there are still many operators who are not entirely familiar with the advantages of the process, the procedures for its application, and the many ways it is used in salvage and repair work. It is felt that a brief review of these three points—advantages, procedures and uses—will aid all operators in getting the most out of the bronze-welding process—particularly at this time when it is often difficult if not impossible to obtain replacements for broken and worn parts.



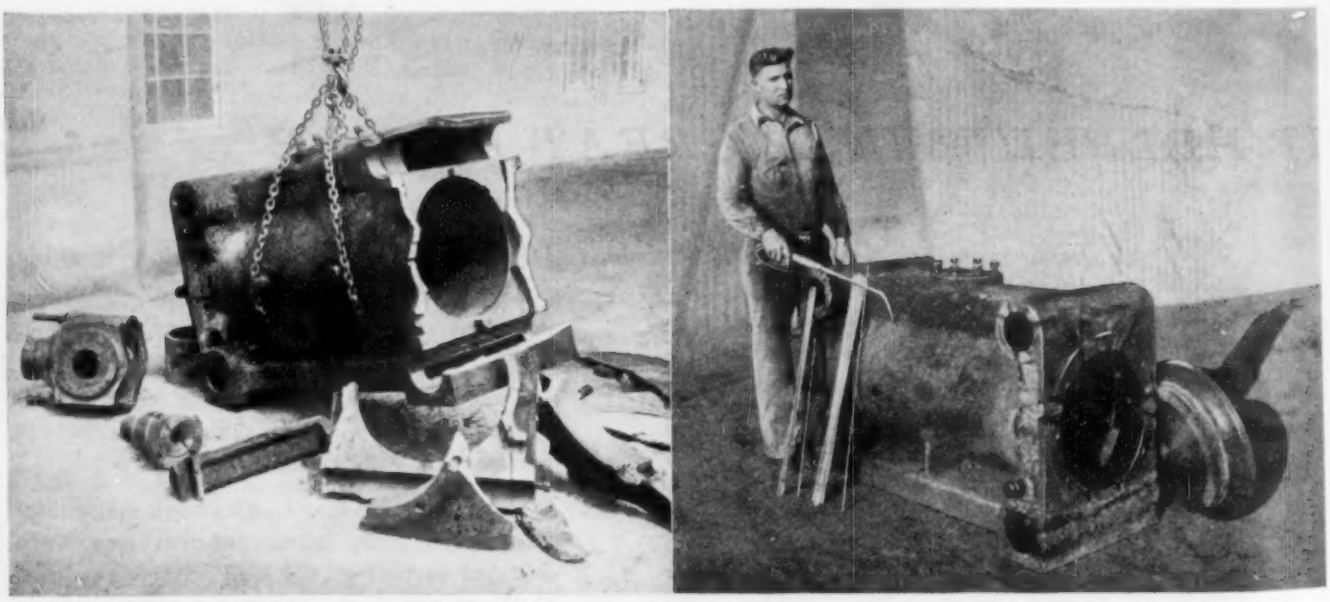
Edges of Metal Over 1/4 In. Thick Should Be Beveled to About a 90° Included Angle, to Assure Complete Penetration For relatively thin sections a coarse file or a hammer and cold chisel may be all that is required, but for thicker sections—in heavy castings, for example—an air chisel, power grinder, or cutting blowpipe will be needed.

Why Bronze Welding Is Easy to Use

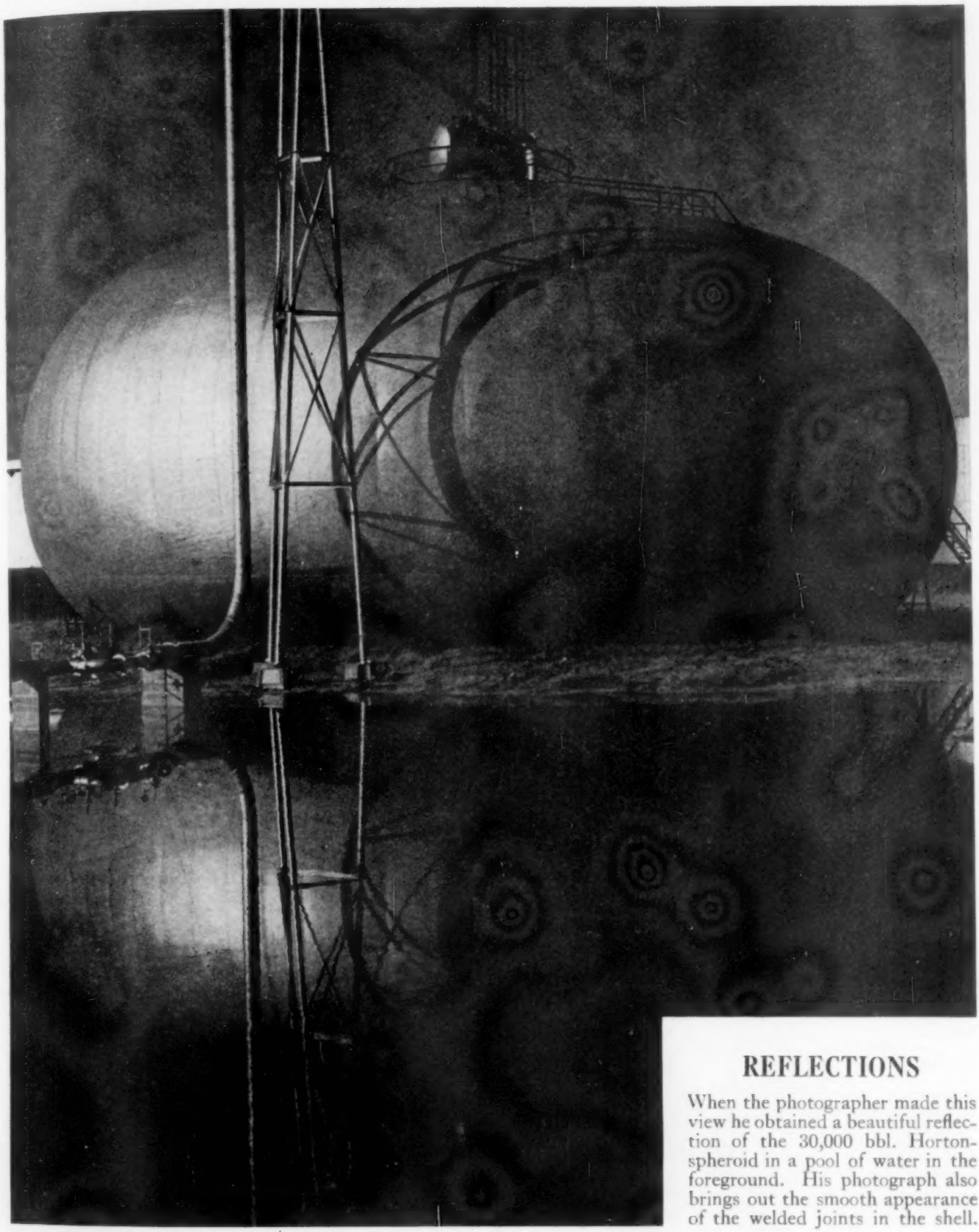
The chief advantages of bronze welding and bronze surfacing may be enumerated in brief as follows:

1. The process is simple because the base metal is not melted.
2. It requires less heat than fusion welding. Thus speed is increased and gas consumptions decreased for a given job.
3. Extensive preheating is not required.
4. Repairs to machinery can often be made without dismantling.
5. The relatively low temperature of bronze welding keeps distortion at a minimum—an important consideration.
6. Low temperature has less effect on galvanized coatings.
7. Heat-treated steels, malleable iron and other metals with properties that might be affected by fusion welding are readily bronze welded.
8. Dissimilar metals can be joined, such as copper or monel metal to steel or malleable iron.
9. A weld made by this process has high strength.

* The Linde Air Products Co., New York, N. Y.



Bronze Welding Converted the Pile of Pieces Shown at the Left Into an 18 x 36-in. Steam Cylinder Casting It was not even necessary to rebore the valve ports. Only a portable electric grinder was used to finish off the welds at the gasket seats.



REFLECTIONS

When the photographer made this view he obtained a beautiful reflection of the 30,000 bbl. Horton-spheroid in a pool of water in the foreground. His photograph also brings out the smooth appearance of the welded joints in the shell.

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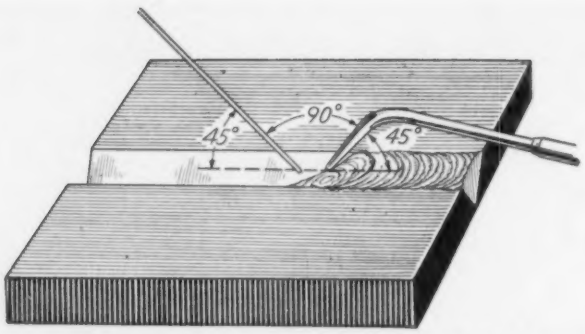
Cleveland 15.....2282 Guildhall Bldg.	Houston 1.....5621 Clinton Drive	San Francisco 5.....1097 Rialto Bldg.

Fabricating plants in CHICAGO, BIRMINGHAM and GREENVILLE, PA.

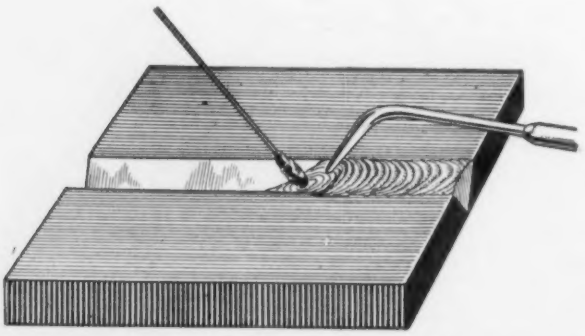


Ease and Speed of Bronze Welding Are Facilitated Quite Appreciably by Proper Relative Positions of Rod and Blowpipe

For a flat weld, hold both the rod and the blowpipe at an angle of about 45° to the surface of the work. Thus, they will form an angle of 90° with each other. Of course, these positions vary considerably for vertical, horizontal and overhead welds.

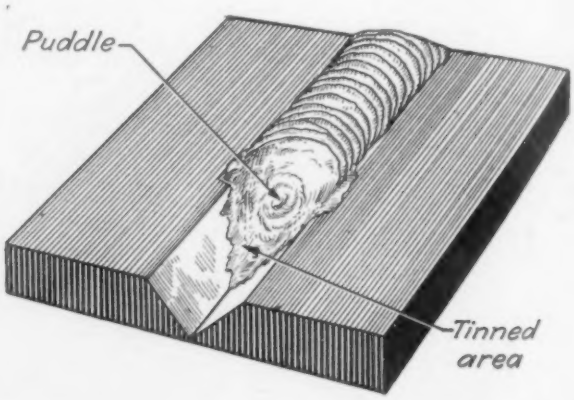
Adjust the Flame Until There Is a Slight Excess of Oxygen

The oxidizing flame is characterized by a colorless or slightly bluish outer envelope and by the complete absence of a secondary flame or feather. The inner cone is somewhat shorter than that of a neutral flame and is not as sharply defined. Sometimes the sides of the inner cone of an oxidizing flame are "necked in" slightly.



Flux Must Be Used Liberally (but Not Wasted) to Prepare the Metal Surfaces, and to Cleanse Them Chemically Even Though They Have Been Thoroughly Cleaned Mechanically

Introduce the flux into the weld by dipping the end of the hot rod into the flux can; by mixing it with water to form a paste and painting it on to the surfaces and rod; or by heating the rod for a foot or 18 in. and rolling it in dry powdered flux.



Tin the Surface Immediately Ahead of the Main Rod Deposit Just as a Tinsmith Tins Sheet Metal Before Soldering

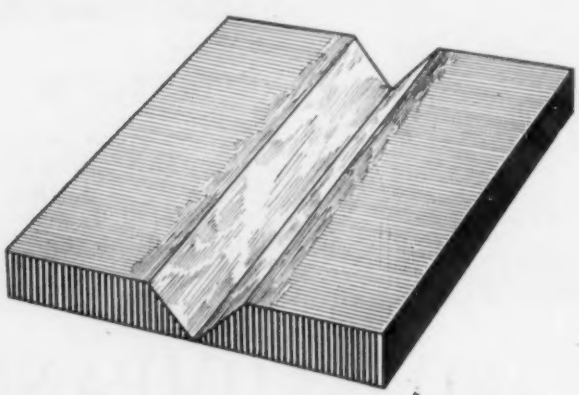
This will be easy—almost automatic—if conditions are right. If tinning is difficult because the bronze tends to form into tiny dancing globules and refuses to spread or "wet" the surface, it is an unmistakable indication that there is too much or too little heat, or that the surface has not been thoroughly cleaned or fluxed.

10. It is easy to execute.
11. It is resistant to wear, particularly sliding friction such as occurs with built-up pistons.
12. It is resistant to corrosion.
13. It will not rust.
14. The finished weld is easy to file, machine or otherwise dress.

Consistently good results are easily obtained with bronze welding, particularly if the operator bears in mind a few fundamental principles,† chief of which are:

1. Bevel edges if base metal is $^1/_4$ in. thick or more.
2. Clean edges thoroughly.
3. Use slightly oxidizing flame.
4. Hold the top of the inner cone $^1/_8$ in. to $^1/_4$ in. from the surface.
5. Use flux liberally.
6. Tin edges thoroughly and carefully.
7. Hold blowpipe and rod at the proper angle.
8. Use a tip one size larger than would be used for fusion welding the same thickness of steel.
9. Cool slowly.

Several of these fundamental principles are shown in the accompanying sketches and the photos are illustrations of typical applications of the bronze-welding process.



Thorough Cleaning Is More Essential in a Bronze Weld Than in Any Other Kind of Weld

All oil, grease, scale, rust or oxide must be completely removed from the edges and from the top surface for about $^1/_2$ in. back from the upper edges of the bevel. Use a grinder, stiff wire brush, file, emery cloth or steel wool.

† Detailed step-by-step instructions in the technique of bronze welding are given in the 16-page booklet entitled "How to Bronze-Weld," obtainable without cost from any office of The Linde Air Products Co.

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THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

NOMINEES FOR DISTRICT VICE-PRESIDENTS

The following list of nominees is published in the JOURNAL in order to provide an opportunity for other nominations.

District #1 (New York-New England): F. C. Fyke, Materials Engineer, Standard Oil Development Co., General Engineering Dept., Elizabeth, N. J.

District #2 (Middle Eastern): H. W. Lawson, Engineer, Bethlehem Steel Company, Bethlehem, Pa.

District #3 (Southern): F. E. McAtee, Asst. Supt., Chicago Bridge & Iron Co., P. O. Box 277, Birmingham, Ala.

District #4 (Central): J. F. Maine, Chief Engineer, Republic Structural Iron Works Co., Cleveland, Ohio.

District #5 (Mid-Western): W. J. Brooking, Director of Testing & Research Dept., R. G. Le Tourneau, Inc., Peoria, Ill.

District #6 (Mid-Southern): M. A. Barrett, Shop Engineer, Beach Aircraft Corp., Wichita 1, Kan.

District #7 (Western): F. A. Longo, General Boiler Inspector, Southern Pacific R. R. Co., San Francisco 5, Cal.

There follows pertinent quotations from the By-Laws:

Article VI, Section 6, By-Laws: "... The nominations made by the Districts shall be published in the April issue of THE WELDING JOURNAL of the AMERICAN WELDING SOCIETY.

"Independent nominations may be made by a petition of twenty-five (25) or more members sent to the National Secretary not later than May 15th; such petitions for the nomination of District Vice-Presidents shall be signed only by members within the District concerned.

"Only District members shall be eligible to vote for District Vice-Presidents."

STRESS MEASUREMENT MEETING

The Spring Meeting of the Society for Experimental Stress Analysis including a Symposium on Residual Stresses, their Measurement, and Effects will be held at the Hotel Statler, Boston 17, Mass., May 18, 19, 20, 1944.

Inquiries should be addressed to Society for Experimental Stress Analysis, P. O. Box 168, Cambridge 39, Massachusetts.

HEATING AND PIPING CONVENTION

The 55th Annual Convention of the Heating, Piping and Air Conditioning Contractors National Association, will be held in Cleveland, May 31st, June 1st to 2nd.

This will be the first convention of the Association in two years, as the 1943 Convention was omitted due to war conditions. For that reason, it is expected the attendance will be the largest the Association ever had, and furthermore, the program for the convention will cover details and technical angles of what the Association thinks will be the leading post-war factors in our industry.

One entire session will be devoted to Certified Pipe Welding. A complete demonstration of oxyacetylene and also arc welding will be given on test pieces which will be tested in a testing machine.

All this will be arranged so the entire convention can watch each step. The presentation will be a part of the program of the National Certified Pipe Welding Bureau.

This Bureau is a division of the national Association, designed to maintain high standards of pipe welding and provide for the interchanging of certified operators among qualified contractors using the "National Procedure."

W. RALPH STICKNEY

W. Ralph Stickney, M.E.I.C., welding engineer for the Canadian Bridge Co., Ltd., Windsor, Ont., was awarded the Duggan Medal & Prize of the Engineering Institute of Canada for 1943 for his paper entitled "Electric Arc Welding." Mr. Stickney gave his paper before the Border Cities Branch of the Institute in November 1942 and was presented with the medal at the annual meeting of the Institute held in Quebec City early in February of this year. The Duggan Medal & Prize is awarded annually to the best paper on constructional engineering involving the use of metals for structural or mechanical purposes and consists of a silver medal and a cash prize of $100.

Mr. Stickney was graduated from the University of Toronto in chemical engineering in 1936 and was with the Ford Motor Company of Canada for one year before joining the Canadian Bridge Co., Ltd., being appointed welding engineer for that company in 1939. He is a registered civil engineer in the Province of Ontario, Secretary-Treasurer of the Border Cities Branch of the Engineering Institute of Canada, and member of the Executive Committee, Detroit Section, AMERICAN WELDING SOCIETY.

ELECTRONICS AWARD

In recognition of its continued "meritorious services on the production front," the United Electronics Co., Newark, transmitting tube manufacturers, has been named to receive the White Star for its Army-Navy "E" pennant awarded last August.

KELLEY-KOETT CINCINNATI SALES-SERVICE OFFICE

Opening of a new sales and service office as a convenience to industrial, institutional and hospital customers in Cincinnati and Southern Ohio is announced by A. H. Feibel, president of the Kelley-Koett Manufacturing Co., Covington, Ky., manufacturers of X-ray equipment.

The Cincinnati sales and service office is located in 1109 Traction Building. This office will serve as headquarters for Ted Tierney, Kelley-Koett representative for the Cincinnati territory, Floyd Tracht, representative for Southern Ohio and Wayne Kruse, service representative.

Feibel reported that the new Cincinnati office will provide convenient facilities for users of Kelley-Koett equipment in Cincinnati and Southern Ohio.

PROTECTIVE CLOTHINGS

The first three of a series of war standards for Protective Occupational Clothing have been approved by the American Standards Association. These are: American War Standard for Leather Aprons (L18.1—1944), American War Standard for Leather Cape Sleeves (with or without bibs) (L18.2—1944), and American War Standard for Leather Leggings (knee length) (L18.3—1944). These standards provide specifications for the different kinds of leather aprons, cape sleeves and leggings, which the committee considered necessary to adequately protect both men and women engaged in industrial occupations. These garments are intended to afford protection from sparks, molten metal, infrared and ultraviolet rays: and also to provide protection from limited impact forces. It is expected that the application of these standards will result in savings in critical war materials.

All three standards contain details as to pattern, design, construction, material and workmanship of the garments covered.

The American War Standards for Leather Aprons (L18.1—1944), Leather Cape Sleeves (with or without bibs) (L18.2—1944) and Leather Leggings (knee length) (L18.3—1944), are printed in one pamphlet and may be obtained for 30 cents a copy from the American Standards Association, 29 West 39th St., New York 18, N. Y.

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THE NEW AO FUL-VUE ACETATE GOGGLE"

If you're looking for new eye comfort and protection, get these attractive green-colored acetate goggles. Equipped with side shields and Calobar lenses, they are ideal for the worker who does light welding or works in the area of welding operations.

Here is why they give better protection. They have a stronger, more massive front than ordinary goggles, while deep grooves in lens rim form a lens seat that resists severe impact. The bridge has just enough face form to give added side protection; and the nose pads, made of heavy stock, have well-rounded edges and ample flare to withstand heavy jolts and blows.

They're more comfortable, too. The light-weight acetate frames rest lightly on the face, and they *stay* snugly in position because comfort cable temples hold them in place. These goggles are ideal for workers who need Super Armorplate lenses ground to their own prescriptions.

This new Ful-Vue Acetate Goggle No. F-8249G comes in 47 mm. eyesize with side shields and is equipped with 6-Curve Calobar Super Armorplate lenses . . . available in 22, 24, and 26 bridge sizes. Order them today from your nearest AO Representative.

American Optical COMPANY
SOUTHBRIDGE, MASSACHUSETTS

X-RAY LITERATURE

Below are listed the titles of new pamphlets on two X-ray accessories.

"Lead Alloy Screens" help to produce better radiographs.

"Magnifying Illuminator" permits more rapid and accurate detection of faults.

Write for copies to Picker X-Ray Corp., 300 Fourth Ave., New York.

SPANISH-ENGLISH DICTIONARY

Engineers' Dictionary—Spanish-English and English-Spanish, by Louis A. Robb, member of the American Society of Civil Engineers, vice-president of Ambursen Engineering Corp., featuring over 44,000 current technical Spanish and American Engineering Terms—with their local variations used daily by engineers throughout Mexico, Guatamala, Honduras, Nicaragua, Costa Rica, Panama, the republics of South America, and the United States. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, 1944, 423 pages, flexible cover, $5^1/_2$ by $7^3/_4$ in. Price $6.00.

Here is the first practical Spanish-English, English-Spanish dictionary of current Central and South American terms for engineers, architects and contractors.

For those engineering plans, specifications, reports, contracts, technical magazine articles, text or reference books—the terms in Robb's Dictionary include a vocabulary of Civil and Construction Engineering in *all* their branches. In addition, many mechanical and electrical terms are included, as well as important terms in geology, chemistry, and allied sciences. This provides the engineer with the essential Spanish and English technical vocabulary needed for office and field work.

PREHEATING

The value of preheating in high-pressure piping systems has been established. Our readers will find the new technical pamphlet of 28 pages of Electric Arc, Inc., 152–162 Jelliff Ave., Newark, N. J., describing the Induction Heating Method, known as the Smith-Dolan Process, contains valuable information on the subject.

THE MANUFACTURE AND FABRICATION OF STEEL

Ferrous Metallurgy, Volume II—The Manufacture and Fabrication of Steel, by Ernest J. Teichert, Supervisor of Metallurgy Extension, The Pennsylvania State College; currently Metallurgist, E. G. Budd Mfg. Co.

This is the second volume of a three-book series prepared by E. J. Teichert, and used in connection with a program of training for persons interested in the iron and steel industry. It covers all the common methods of manufacture and processing steel, including its primary fabrication. Every known care has been exercised to present the subject matter in as clear and concise a manner as possible. The extent of the work, however, prevents treating all the subject matter in minute detail. It is believed that the student of this text will obtain a very clear idea of all the processes covered. Several chapters are concerned with welding.

Published by McGraw-Hill Book Co., Inc., New York. Price $4.00.

FIFTY YEARS OF SERVICE

1944 is the year in which Underwriters' Laboratories, 207 E. Ohio St., Chicago 11, Ill., celebrates the completion of its first fifty years of service and begins its second fifty.

The Laboratories has come a long way in its ability to serve its clients, its sponsors and the public since the start half a century ago in a small room "over the horses" of Fire Patrol Station No. 1 on Monroe St., Chicago, where the staff consisted of one engineer, an assistant and a clerk, and its laboratory equipment was a bench, a table, a few chairs and $350 worth of electrical equipment.

Like many other developments which have grown to importance in the last five decades, Underwriters' Laboratories was an outgrowth of the first Chicago World's Fair, the Columbian Exposition of 1893. A feature of the Fair was to be a lavish display of incandescent bulb lighting in and on the buildings. This type of lighting was then new, having only recently come out of Edison's laboratory. During the period of construction a number of

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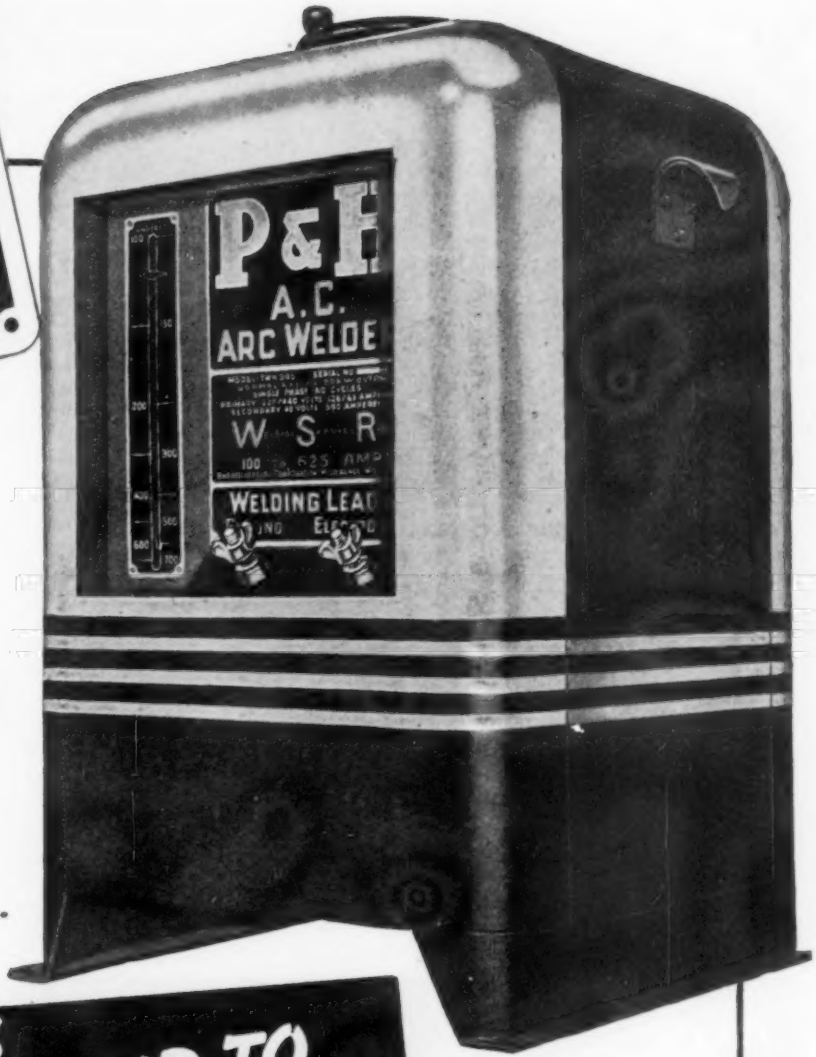
P&H
— AC — ARC WELDERS



WELD

from 15% to 30%

FASTER!

14 MODELS CAPACITIES UP TO 1200 AMPS

Swifter Production

Liberal capacity permits use of larger electrodes. Easier control of molten pool enables you to weld from 15 to 30% faster—makes shorter work of all kinds of jobs, including intricate, close-corner welding.

Easier Operation

Micromatic adjustment gives you an infinite number of settings. One single creep-proof control provides stable current that "stays put" where you want it.

WSR (Welding Service Range) Ratings

Every model carries a WSR rating plate which specifies actual *usable* welding range from minimum to maximum. There's no guesswork.

Greater Values

Quality-built to last for years. No rotating parts to wear. Maintenance costs are practically eliminated. Write for complete information on P&H A. C. Arc Welders. Models up to 1200 amperes capacity. *Ask also about P&H Electrodes for A. C. Welding.*

P&H is America's only manufacturer providing a complete welding service including A. C. and D. C. Arc Welders, Welding Electrodes, Welding Positioners, Electric Hoists, Overhead Cranes, Etc. Write for Literature.

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HARNISCHFEGER CORPORATION

ARC WELDERS · EXCAVATORS · ELECTRIC CRANES · P&H · MOTORS · HOISTS · WELDING ELECTRODES

Canadian Distribution: The Canadian Fairbanks-Morse Co., Ltd.

fires occurred in the fairground buildings. Some of these were caused by the "new-fangled" lighting. Apprehensive that this new lighting method might prove hazardous, insurance interests in Boston sent an engineer to Chicago to investigate the situation. That engineer was William Henry Merrill, founder-president of Underwriters' Laboratories.

Because of the increasing volume of testing required by eastern manufacturers, a New York City testing station was opened in 1912. The work at this station is primarily in electrical, fire alarm and burglary prevention fields. Consultants are available at that office for discussing with manufacturers the nature of tests of other types of equipment. The Laboratories' facilities at New York practically duplicate those of the Electrical and Burglary Protection departments at Chicago. The testing station, at present, occupies a complete floor of the Butterick Building at 161 Sixth Ave.

To serve the western part of the United States a third testing station was opened in 1923 in San Francisco. This laboratory, mainly for electrical work, is located at 500 Sansome St. Its electrical apparatus is similar to that at the main testing station in Chicago.

For extra hazardous work involving high explosives, toxic gases and other dangerous products, a fourth testing station is maintained out in the country about 35 miles from Chicago. This testing station was opened in 1929. Here the engineers make nitroglycerine for blowing safes designed for burglary protection, test professional motion picture equipment for projection or storage of nitrocellulose film and carry on other investigations and research which are too dangerous to conduct in a crowded city.

Three hundred seventy-five thousand products have been approved by Underwriters' Laboratories to date and are listed in its booklets of tested and inspected items. As 50% fail the first time they are tested, many more than 375,000 products have been investigated. The 5000 manufacturers of approved devices, materials and systems produce in a normal year, in their more than 5500 factories, half a billion of these safeguarded articles.

METRO POSITIONER

The Metro-Vise Co., 6560 Cass Ave., Detroit 2, Mich., has issued a folder on the new Metro Positioner. This new tool is for holding or clamping work during operations such as checking, milling, drilling, shaping, boring, welding, filing, pattern making and similar work. Copy available on request.

AMERICAN COUNCIL OF COMMERCIAL LABORATORIES

Executives and Administrators will be interested in learning of the publication and availability of a Directory of the American Council of Commercial Laboratories. This Directory endeavors to furnish business and governmental executives, as well as other interested parties, with a means of acquiring information about the scope of activities of independent laboratories and the advantages to be derived from utilizing their services in the solution of scientific, engineering, testing and inspection problems.

The Directory includes statements of the member laboratories describing their organizations, executive officers, personnel and the presentation of their customary services and specialties. Many of these laboratories are pre-eminent in their own highly specialized fields. All of them are prepared to offer guidance in selecting the right laboratory for a particular problem.

Copies may be obtained from the Executive Secretary, A. J. Nydick, 63 Wall St., New York 5, N. Y.

THE LIGHTNING P-38

Capable of flying over Berlin, a new long-range Lightning P-38 has been sent into action by the U. S. Army Air Forces, the War Department announced recently.

By virtue of engineering improvements in recent months, the new fighting Lightning retains its title as the most versatile of America's warplanes, and boasts the longest range of any fighter.

Vastly improved in various performance phases over the Lightnings which already rule the combat skies, the new model P-38's have been rolling from the Lockheed assembly lines for sometime.

This twelfth model of the Lockheed Lightning, capable of carrying two 1000-

THE RESULT OF YEARS OF THE MOST EXACTING RESEARCH IN THE WELDING TRANSFORMER FIELD

HERCO ARC WELDERS

PRECISION CONTROL
Variable Core construction permits stepless heat changes while welding. Magic Eye-Pilot indicates when machine is on.

STREAMLINED ARC
Instantly starting, smooth, flexible. Elimination of "arc blow" produces sound, speedy and uniform welds. X-Ray test beads.

LOWER COST
Power cost 50% lower than motor generators. No rotating parts at all, therefore supervision, oiling, replacement of wearing parts eliminated.

POWER FACTOR
corrected welders if desired.

HEAVY DUTY CONSTRUCTION
Continuous 24 hour per day operation. Sturdy connectors, on-off switch or circuit breaker for lifetime of wear. Spun glass insulation. Durable sheet-steel housing. Easy rolling, portable.

MODELS
available from 150 to 2000 amperes.

OTHER PRODUCTS
Manufactured by Hercules
are
MAGNETIC ALIGNERS
AC-DC RECTIFIERS
HEAVY DUTY—
THREE PHASE SOLENOIDS
FOR AUTOMATIC SPOT WELDING

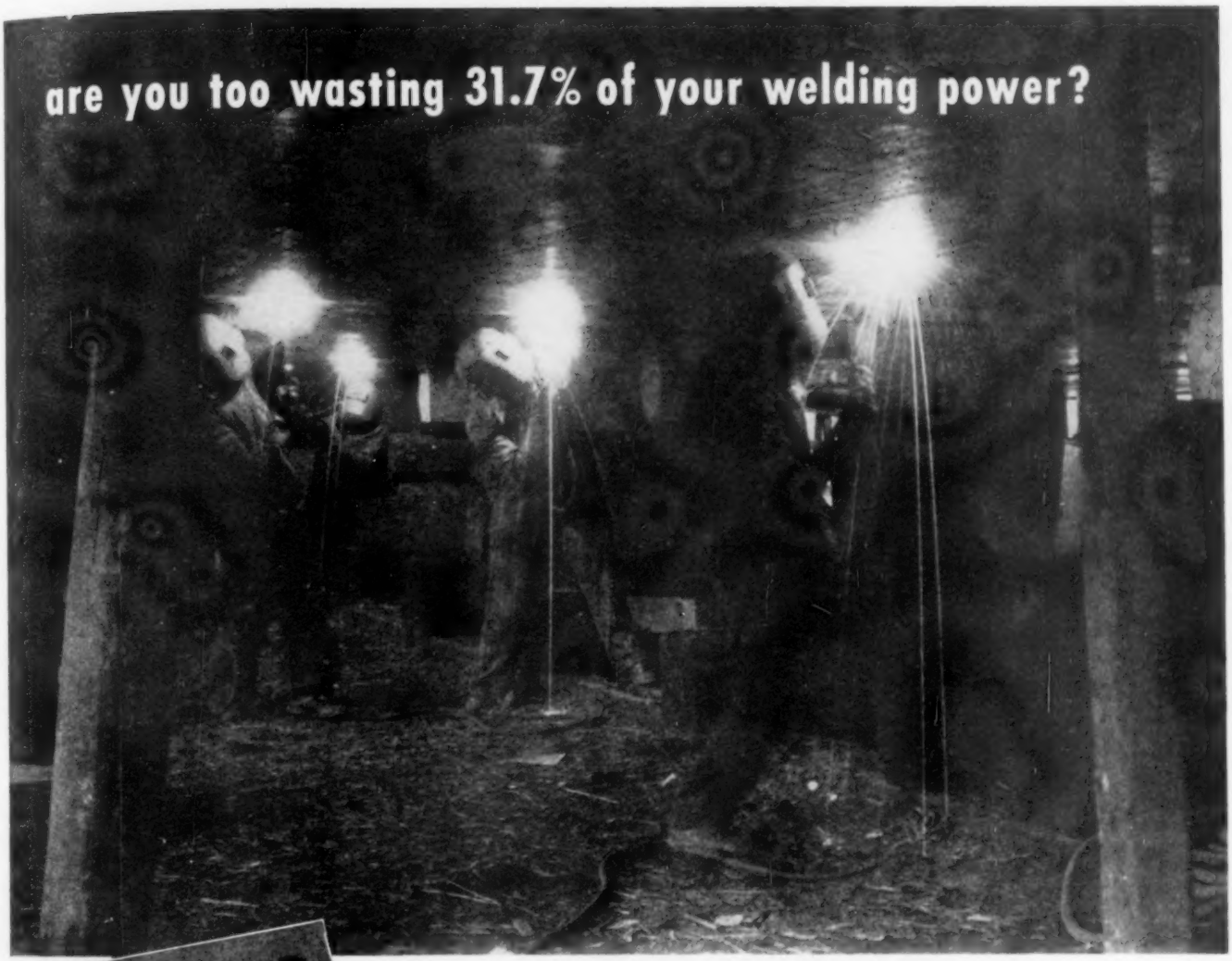
WRITE FOR LITERATURE

VC—250
(40 - 250 amps)

VC—375
(50 - 375 amps)

HERCULES ELECTRIC & MFG. CO. INC.
MANUFACTURERS OF THE PRECISION WELDER WITH THE STREAMLINED ARC
2416 ATLANTIC AVENUE BROOKLYN, N. Y.

are you too wasting 31.7% of your welding power?



The -hp- model 1010 Automatic Welding Machine Starter with Arc-time Totalizer is designed to operate in conjunction with any standard welding motor-generator set. It starts the welding machine when the welder touches the rod to the work. After a short interval of no welding, the control automatically stops the machine. Whenever welding is in progress, arc-time is counted by synchronous totalizer. The totalizer does not operate when the rod is shorted to the work, thus only actual arc-time is recorded.

WELDING engineers in one of the largest U. S. shipyards discovered that 75% of the 21-hour day when their welding machines were actually turned on, was "idling time." The net power waste was 31.7% of the total current used by the machines. To end this needless waste of war-time power, and cut welding costs, these engineers installed on over 500 welding machines, the *-hp- Arc-O-Mat (Automatic Welding Machine Starter with Arc-Time Totalizer).*

Then these engineers kept careful records of actual operations. Their published report shows that these new controls paid for themselves in 6 to 7 months, and then kept on saving about 31.7% of the welding machine power cost each month.

Their report also shows other savings made, and suggests that *4 times as many welding machines may be operated on the same facilities* after these *-hp-* controls are installed. This saving is possible to industries installing facilities, converting plants, or expanding operations. Besides, the report shows how the Hewlett-Packard Arc-Time Totalizer attachment supplies the missing link in other methods of production welding control . . . how it helps to increase production by pointing out bottle-necks and delays from whatever cause.

ASK FOR A COPY OF THIS REPORT

This report will probably unpleasantly surprise you at the waste it may reveal in your own welding operations. The simple and profitable way to end this waste, found by these engineers, will be a pleasant surprise. You incur no obligation . . . just write for the "Shipyard Waste-Power Report" today—NOW!

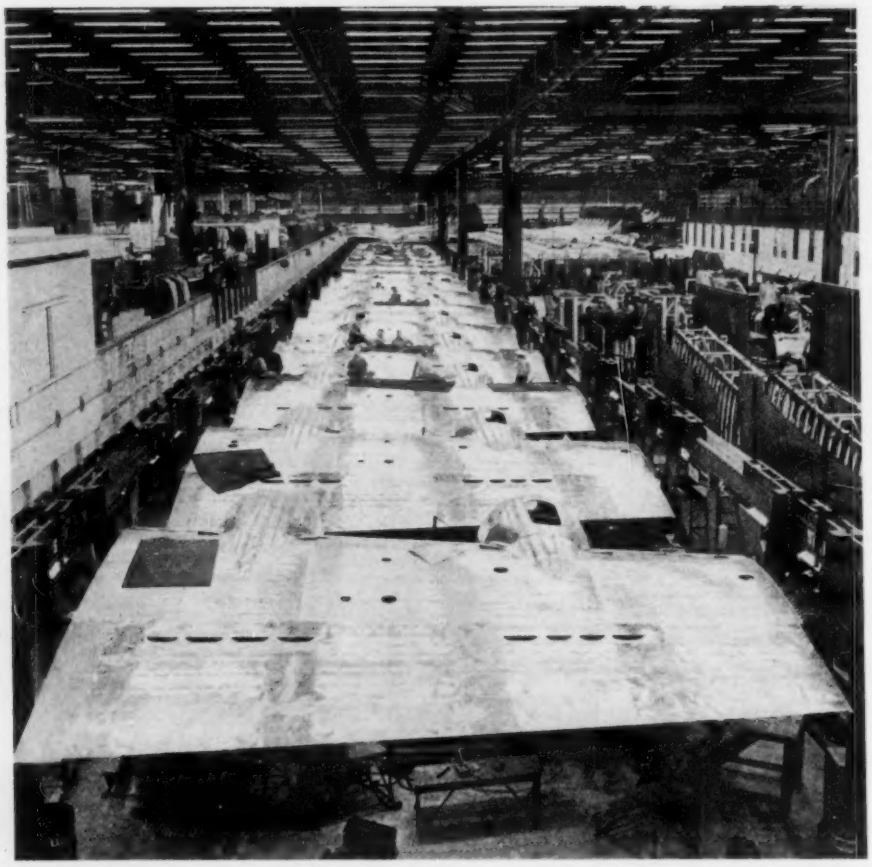
hp

ARC-O-MAT

HEWLETT-PACKARD COMPANY

Box 807E, Station A • Palo Alto, California

807



Shown in the Photo Are the Heavy Bomber Inner Wing Sections Which Have Just Left Their Three-Story Fabrication Jigs and Are Now in the Way Down to the Final Assembly Area Where They Will Be Attached to Waiting Fuselages. In This Line Two Engines Are Hung on Each Section, Along with Fuel Tanks, Electric Wiring and Plumbing. The Huge Sections Rest on Rollers at Each End and Move Along a Wide Track. Workers Have Access to Both Top and Bottom of the Units

pound bombs, double that of any single-engine fighter, packs the heaviest bomb load of any fighter-bomber.

Major improvements in the new model, which caused the Army Air Forces to greatly expand Lockheed's production of the twin-boomed, twin-engined Lightning by means of a subcontracting program enlisting major American industries, are:

Horsepower increased 30%, from 2300 to 3000.

Rate of climb increased 100% at altitudes over 30,000 ft., and materially increased at all altitudes.

Built-in, bulletproof range increased 30%, permitting the Lightnings, when desired, to accompany bombers on escort missions deeper into enemy territory than any other fighter.

Service ceiling (the point where a plane is able to climb 100 ft. a minute) increased to "well above 40,000 ft." with better performance all the way up. Just how high above 40,000 ft. remains a military secret.

Straightaway speed increased, depending on altitude. The P-38 was the first production airplane to better 400 miles an hour.

Single-engine speed increased to over 300 miles an hour.

Combat maneuverability more than doubled by mechanical aids to the pilot, in the form of hydraulic aileron boosters combined with the old combat flap.

New unit power controls and automatic temperature controls that further simplify the operation task of the pilot.

Installation of an improved turbo-supercharger and new intercooler installations, boosting the power of the twin-Allison engines from 1150 to 1500 hp. each. This tremendous power vastly increases the Lightning's superiority over Axis fighters. When the vaunted Zero, for example, which weighs less than half that of the Lightning, is at top speed in level flight, the now P-38 is flying faster and also climbing more rapidly. The Zero's rate of climb falls off at 15,000 ft. but the Lightning climbs with top efficiency to nearly twice that altitude.

On the score of versatility, the Lightning stands out ahead of all other fighting aircraft in that it is used as a high-, low- and medium-altitude fighter, an interceptor, a bomber escort, for ground strafing, as a tank buster, dive bomber, skip bomber, night fighter, for smoke screening and as a glider tow. In its photographic version, it is the fastest photo-reconnaissance plane of the Army Air Forces.

Lightnings were the first fighter-type aircraft to fly the Atlantic, and by using droppable auxiliary fuel tanks the P-38's are now capable of ferrying any ocean.

Armament of the new long-range P-38 remains the same as predecessors, consisting of one 20-mm. cannon and four 0.50-calibre machine guns, concentrated in the nose to give greater straight-ahead fire power over a longer range.

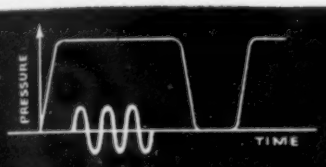
Externally the new P-38 appears almost unchanged, and structurally it remains the same sturdy Lightning which has flown home on one engine—"the round trip ticket"—after striking telephone poles,

IMPORTANT
POINTS
OF SUPERIORITY

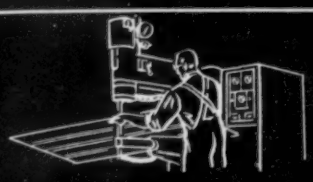
1. Fear of overheating can be forgotten.
2. Cleaning and grinding are unnecessary with "York's 77".
3. Chipping is unnecessary with "York's 77". A satisfactory bond is always guaranteed.
4. Deteriorated cast iron can be welded with "York's 77".

make YORK'S 77 CAST IRON BRAZING FLUX THE PREFERRED FLUX IN SCORES OF WAR PLANTS

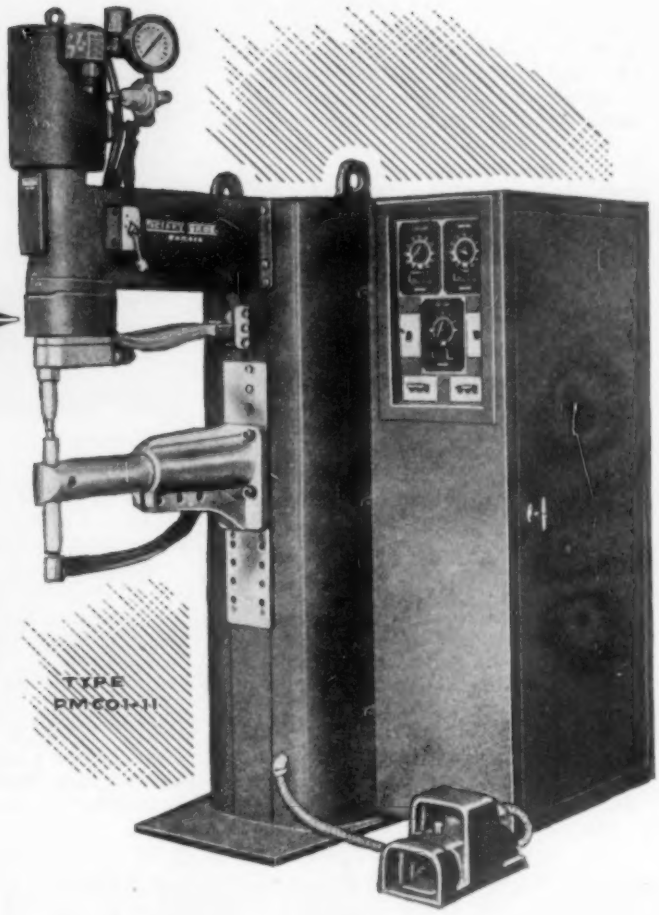
Send for FREE Sample
YORK ENGINEERING COMPANY
3349 OGDEN AVENUE • CHICAGO 23, ILLINOIS



high welding pressure-precise welding current



200 spot welds per minute



. . . mean high quality, high production welding on light gauge ferrous alloys.

This 60 KVA Sciaky Spot Welder is specifically designed for the high quality welding of stainless steels, mild and zinc-coated steels, monel metals, brass and copper. The high pressure (up to 2600 lbs. psi) and electronic current timing assure high shear values wherever structures are subject to stresses and vibration.

Note these additional exclusive Sciaky features.

SELF-CONTAINED UNIT . . . Electronic controls and ignitron contactor are mounted in a hinged cabinet convenient to operator . . . simplifies installation.

SCIAKY ELECTRONIC TIMER . . . The patented Sciaky Timer uses no intermediate relay, but operates a heavy duty relay direct from the tube.

TRANSFORMER . . . Secondaries are hard rolled copper — having less tendency to overheat than cast.

HEAD RETRACTION . . . Retraction of 2¼" is controlled by foot switch. Short working stroke (½") eliminates tendency of electrodes to hammer.

SCIAKY ELECTRO VALVE . . . Air to the operating cylinder is controlled by a specially designed, fast-acting d.c. operated solenoid valve.

FLEXIBLE BRAIDED CABLES . . . These are used between the transformer and upper electrode and result in less tendency for fatigue breaks.

FOOT SWITCH . . . Stroke on hooded foot switch is ¼"—operator need not raise entire foot from floor.

AUTOMATIC WATER SHUT-OFF . . . Water supply to electrodes is cut off when head is retracted or control switch off—means quicker electrode change.

SCIAKY BROS.

Manufacturers of a Complete Line of A-C and D-C Electric Resistance Welding Machines

4915 W. 67th STREET, CHICAGO, ILLINOIS

Sciaky specializes in the design and construction of special equipment. Consult us on your resistance welding problems.

ship masts, enemy airplanes, being riddled by enemy fire.

Development of the Lightning started several years ago, and it has been constantly improved by Lockheed engineers, headed by Hall L. Hibbard, vice-president and chief engineer, with the cooperation of the technicians of the Matériel Command, Wright Field, Dayton, Ohio.

Lockheed has completely equipped spot- and roll-welding departments in which more and more parts are continually being added to the list of subassemblies being put together by resistance welding in place of rivets.

Probably no airplane today has added more to the development of resistance welding than the P-38. Accelerated production schedule designed to double and redouble all previous output rates would not be possible but for the high-speed subassembly work done in the spot- and roll-welding departments. Even much of the outer skin sections of the Lightning, such as the steel cowling, is being spot and seam welded.

CHAMP RETAINS TITLE

Vera Anderson, 20-yr.-old welderette deluxe at Ingalls Shipbuilding Corp. in Pascagoula, Miss., successfully defended her title as the world's woman arc-welding champion when she recently defeated the challenger, Mrs. Edna Slocum of Moore Dry Dock, San Francisco.

In the roped off "ring" on the platen at Ingalls the champ and challenger "fought it out" on the basis of welding speed and quality in a variety of tests including overhead and vertical welding.

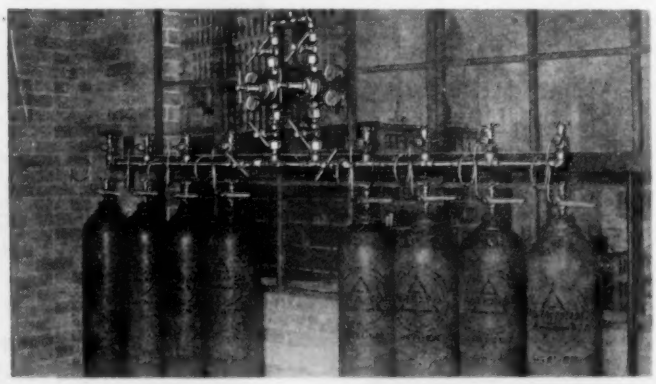
Courtesy Lincoln Electric Co.

Miss Anderson was recently chosen one of the ten outstanding women of the year by the Associated Press and by a national woman's magazine after winning her championship crown last year.

REPAIR PARTS DIVISION FOR P & H

Anticipating a growing demand for repair and replacement parts as a result of war production burdens on equipment, and to facilitate service to customers, a separate division for handling such business on all P&H products was recently established by Harnischfeger Corp., Milwaukee. The new Repair Sales Division is being managed by J. D. Glatz, recently returned from Washington after two years with the WPB as chief of the crane and hoist section in the tools division. Prior to that, he was representative for P&H in the Chicago area. Operations of the division under Mr. Glatz are of much wider scope than usual, because of the

J. D. Glatz



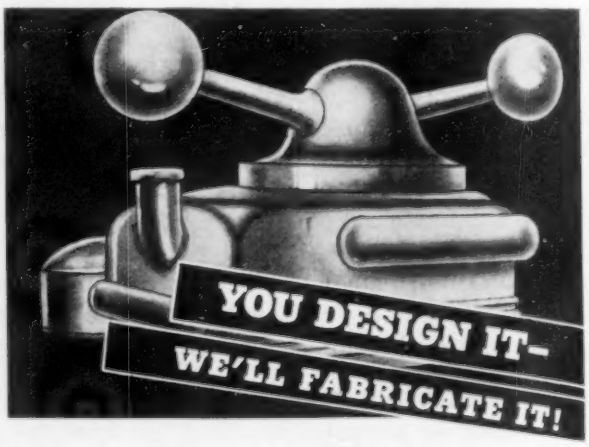
BRASS *MAKES* **BULLETS**

REGO Gas Plant Equipment to be safe, must be made of brass and other critical metals.

Conserve your equipment. You may not get more.

REGO ARMY NAVY UL

The BASTIAN-BLESSING Co.
4241 W. PETERSON AVE. CHICAGO
Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases



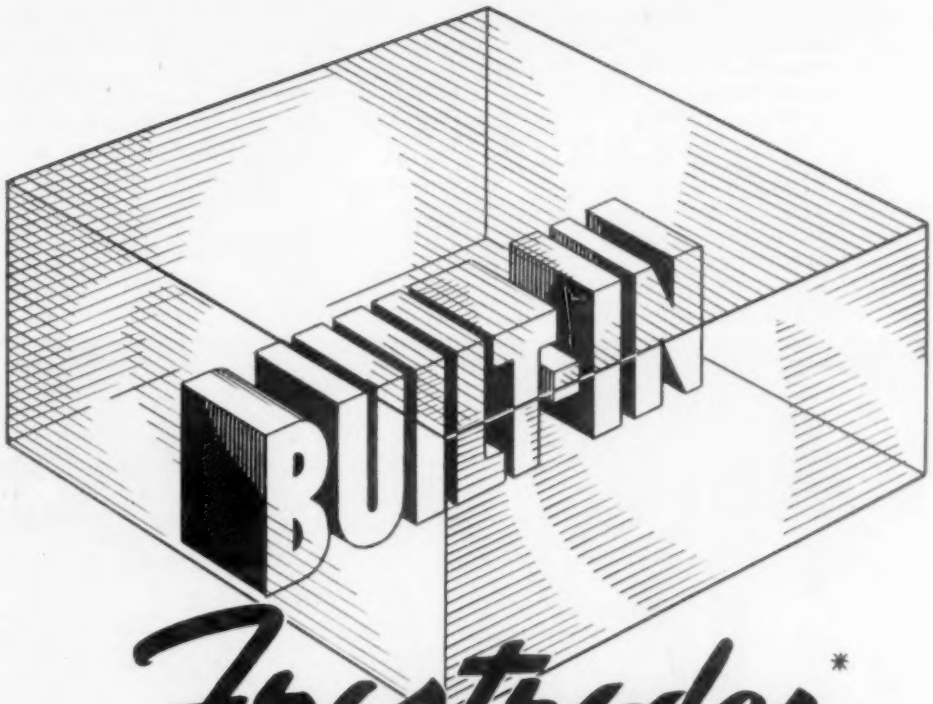
An unusual design... but not improbable. Stranger things than this will flash upon the post war scene. When such a design is created, the logical source for fabrication of the housing and various interior parts would be United Welding Company.

Parts so welded are lighter, stronger, more dependable. Pattern costs are saved. Rounded corners, unusual contours are produced with ease.

United Welding has the facilities and the engineering staff to handle your most complicated and difficult fabrications.

Plan to weld as much of your product as possible. Lay it out with that thought in mind. Then contact United Welding Co.

THE UNITED WELDING COMPANY
MIDDLETOWN, OHIO



Frostrodes*

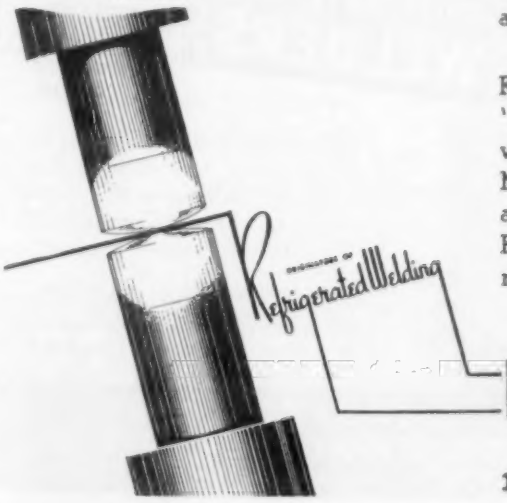
by

Leading Producers of Resistance Welding Equipment

In Addition the following bulletins are available:

Bulletin No.

F-43 The Frostrode Process
P-43 Frostpoint Electrodes and Frost-caps.
HR-43 Cooling Efficiency Tests by Dr. Hess
EA-43 Experiences at Eastern Aircraft
DS-43 What Users Say about FROST-RODE



ZERO-Welding has now become so important and so widely accepted that leading producers of resistance welding equipment are either offering or preparing to offer such machines as rocker-arm and pedestal welders with built-in Frostrode refrigeration units, particularly for welding of aluminum.

Frostrode units can be designed to fit into practically any resistance welder produced. The advantages include not only a saving in floor space but also still higher efficiency due to even lower insulation and pressure losses through closer coupling.

For welders already in operation, there are the standard Frostrode "packaged" units, the popular Model 751 for one light aluminum welder, and Model 1501-E, Model 3002, Model 5001, Model 7501, Model 1001 Frostrodes that handle two, four, six, ten and fourteen aluminum welders respectively, or an equivalent load of steel welders. For complete information ask for bulletins on the machines by model number.

FROSTRODE PRODUCTS

19003 JOHN R ST. • DETROIT 3, U. S. A.

* Registered Trade Mark

wide line of P&H products, including electric overhead traveling cranes, hoists, a.-c. and d.-c. welders and welding electrodes, welding positioners, and gasoline, Diesel, and electric-powered tools.

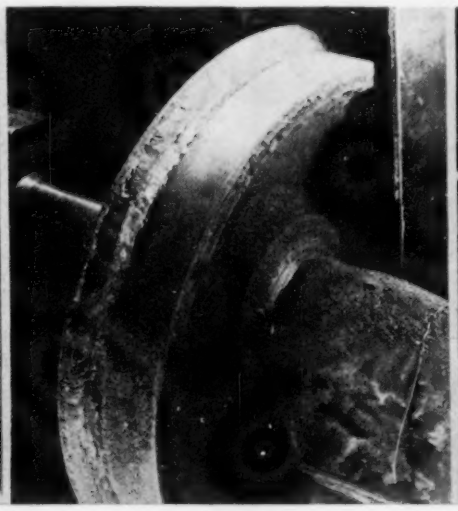
REFACING WORN CAR WHEEL FLANGES

A simple, layer-on-layer arc-welding process accounts for a 50% saving in the cost of refacing abrasion-worn flanges of car wheels in the repair shops of the Philadelphia & Western Railway Co., according to Fred Strawbridge of the Arcway Equipment Co., Philadelphia, Pa., General Electric arc-welding distributors.

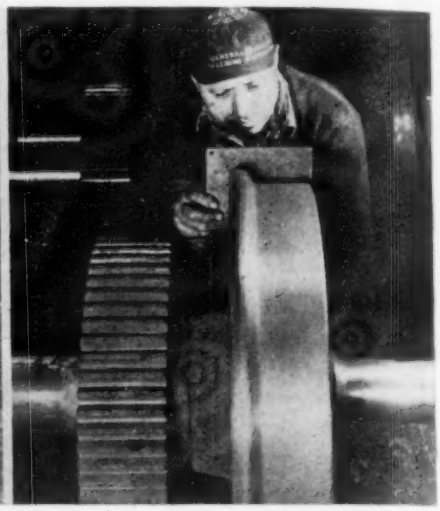
The flanges can be refaced approximately four times by this process before the treads of the wheels become worn to the point where they are scrapped. The treads are not refaced because of the possibility of fracture, produced by shrinkage stress, appearing while in use on the company's high-speed service line between Philadelphia and Norristown.

This company inspects every car completely at regular intervals, keeping a record of the condition and mileage of each wheel. As it operates various types of cars, the company uses wheels of different weights made according to individual specifications. The exact analysis of the steel in these various wheels is known only to the manufacturer, but in general they have a high carbon content, particularly on the tread and flange where the brake and side thrust cause wear.

Car Wheel with Flange Worn by Abrasion, Being Checked with Template to Determine Amount of Wear



Car Wheel with Flange After Being Built Up by Arc Welding. Close-Up View Showing Appearance Before Being Ground



Finished Car Wheel Being Checked with Template Before Being Placed in Service

Is this YOUR Cleaning Problem?
Preparing Welded Steel Surfaces for Painting
After resistance, gas or arc welding of steel surfaces, a prime requisite for effective paint adhesion is a clean, GREASE-FREE surface.
Various specialized Oakite acid and alkaline type materials are available for this essential surface preparation work. ALL provide the CLEAN surface that assures firm, tenacious bonding of paint or similar organic finishes.
If you are experiencing trouble on this type of work, let us help you correct it. Oakite Technical Service is FREE for the asking.
OAKITE PRODUCTS, INC., 18E Thames St., NEW YORK 6, N.Y.
Technical Service Representatives Conveniently Located in All Principal Cities of the United States and Canada
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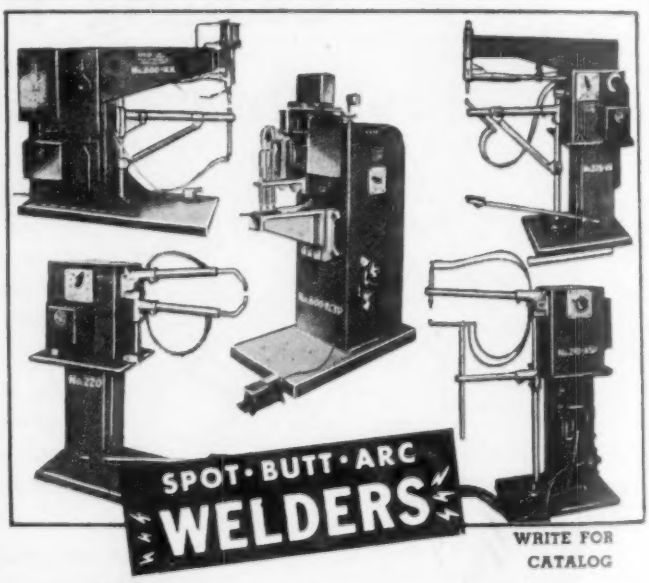

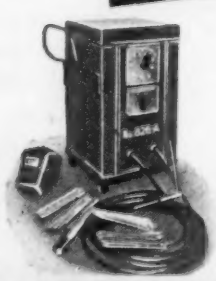

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Before being welded, the wheels are preheated with a blow torch to 350° F. Then, using 1/4-in. electrodes with approximately 250-amp. d.-c., straight polarity, a single-layer bead of metal is welded with a weaving motion on the worn surface of the tread around the entire circumference of each wheel. The width of the bead is determined by the use of the template, and care is used to meet the flange with exactly the proper degree of penetration.

After all slag and spatter are removed by light grinding, a second and third, and, if necessary, a fourth layer are added, each layer covering a little more of the flange, until it is built up to its proper height as determined by the template.

Since the welding process heats the wheels to nearly 800° F., they are then suitably covered to protect them from room temperature so that they will cool gradually. The cooling period requires about 12 hr. The wheels are then returned to the wheel truck, the front end of which is raised and the front axles mounted on lathe centers, so that the treads and refaced flanges can be finished by very light grinding. The wheels are then ready to be put into service.

Originally this company experimented with many types of electrodes for this work. Since the grinding operation was not then used, it was found necessary to adopt an electrode that could be machined.

Later the necessity arose for an electrode whose deposit was harder and hence capable of giving better wearing qualities. Again different electrodes were tried out, during which time the grinding operation was incorporated into the refacing process. Each time a change was made from one electrode to another, the electrode cost and the cost of the deposited metal increased. However, the increased mileage gained from the use of the harder deposits, and the consequent decrease in the time required for the grinding, gradually reduced the maintenance cost per wheel. The G-E Type W-93 electrode was selected.

OBITUARY

Lawrence Henry Dunham

Lawrence H. Dunham, a member of the AMERICAN WELDING SOCIETY, passed away suddenly on January 19th in a hotel in Pittsburgh, Pa., while attending some metallurgical meetings. Mr. Dunham was assistant manager, Metallurgical Department of the American Steel and Wire Co., with offices in the Rockefeller Building, Cleveland, Ohio.

Lawrence Henry Dunham

Mr. Dunham was born in Chicago, August 1891, his parents being the late Arthur Henry Dunham of LaSalle, Ill., and Margaret Barrett Dunham, now of Lakewood, Ohio. The family moved from Chicago to LaSalle about 1908 where Mr.

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Dunham attended the LaSalle-Peru high school, graduating in 1911 and receiving a scholarship to the University of Illinois. He was graduated from the University of Illinois in 1915 with a B.S. degree in chemical engineering and metallurgy. While in college he was a member of the Congregational Guild, American Chemical Society, Chemical Club, being vice-president in his senior year, Phi Lambda Upsilon, honorary chemical, and Scabbard and Blade, honorary military fraternities, and was a Lieutenant, Junior Year and Captain, Senior Year in the R.O.T.C.

Mr. Dunham began his career with the Inland Steel Company, Indiana Harbor, Ind., in 1915. In 1916 he accepted the position of laboratory assistant at the Newburgh plant of the American Steel and Wire Co., Cleveland, Ohio. In 1919 he was laboratory director, 1928 assistant to the chief metallurgist and in 1937 was transferred to the Chicago offices as district metallurgist. In 1940 he was transferred to Waukegan, Ill., as works metallurgist, where he helped supervise the building of the new Metallurgical and Chemical Laboratory and secure the proper testing machines and equipment. In April 1942 he was transferred back to the Cleveland offices as assistant manager, Metallurgical Department.

Mr. Dunham was a member of the following technical societies: AMERICAN WELDING SOCIETY, American Iron and Steel Institute, American Society for Metals—Charter Member, Cleveland Chapter, American Society for Testing Materials—being on the Joint Committee on Filler Metal (A.W.S. and A.S.T.M.); Sub-Committees of Joint Committee II. Iron and Steel Gas Welding Rods and IV. High Alloy Steel Filler Metal.

Mr. Dunham leaves his widow, Mrs. L. H. Dunham (formerly Alsia Strode of Champaign, Ill.); a daughter, Doris Jean, primary teacher at Ashland, Ohio, having graduated from DePauw University, Greencastle, Ind.; a son, Air Cadet Larry S. of Craig Field, Selma, Ala., who was a junior at DePauw University when inducted into the Army Air Corps, February 1943; and his mother, Mrs. A. H. Dunham—all of Lakewood, Ohio; and a brother Arthur Barrett Dunham of Omaha, Nebr., and nieces and nephews.

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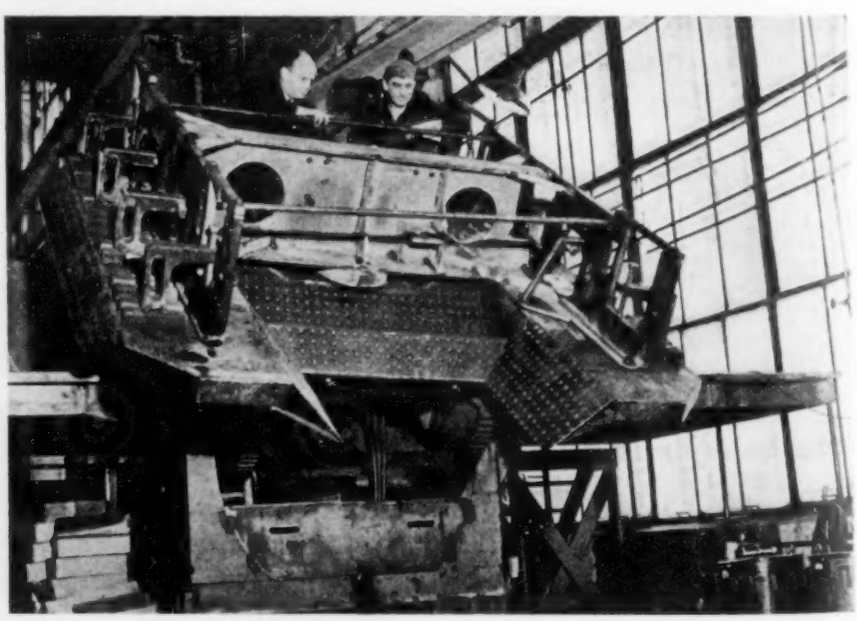

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Nickel (pure, wrought and cast)
"D" Nickel, "Z" Nickel
Inconel (wrought and cast)
Hastelloy A, B, C, D
Illium G, R
Alcoa 2S, 3S, 17S, 52S, 53S
Alclad 24S
Alcoa 13, 43, 195, 214, 220
Copper
Red Brass (wrought and cast)
Yellow Brass (high brass)
Naval Brass (Tobin bronze)
Admiralty Brass
Muntz Metal
Manganese Bronze
Silicon Bronze
Phosphor Bronze 5%
Aluminum Bronze
Beryllium Copper
Nickel Bronze (cast)
Nickel Silver 20% (cast)
Nickel Silver 18% (wrought), 13% (cast), 10% (wrought)
Ambrac 20%
Cupro-Nickel 70-30, 55-45
Tin
Chemical Lead
Antimonial Lead
Tellurium Lead
Soft Solder 50-50, 60-40
Zinc
Zilloy 15, 40
Dow Metal E, H, R, X
Silver (pure)
R-T Silver Brazing Alloy
Easy-Flo Silver Brazing Alloy
Gold (pure)
Platinum (pure and commercial)
Iridium-Platinum 10%
Rhodium-Platinum 10%
Palladium (commercial and hard)
Tantalum
Iron (wrought, ingot and cast)
Ni-Tensyliron
Ni-Resist (standard and copper-free)
Ni-Hard, low carbon, high carbon
Carbon Steel (SAE 1020)
Cast Carbon Steel
Cast Alloy Steel
Stainless Steel 304, 309, 310, 316, 321, 347, 325, 410, 420, 430, 446, 312, 330
Cast 18 Cr 8 Ni Steel
Cast 18 Cr 8 Ni 3 Mo. Steel
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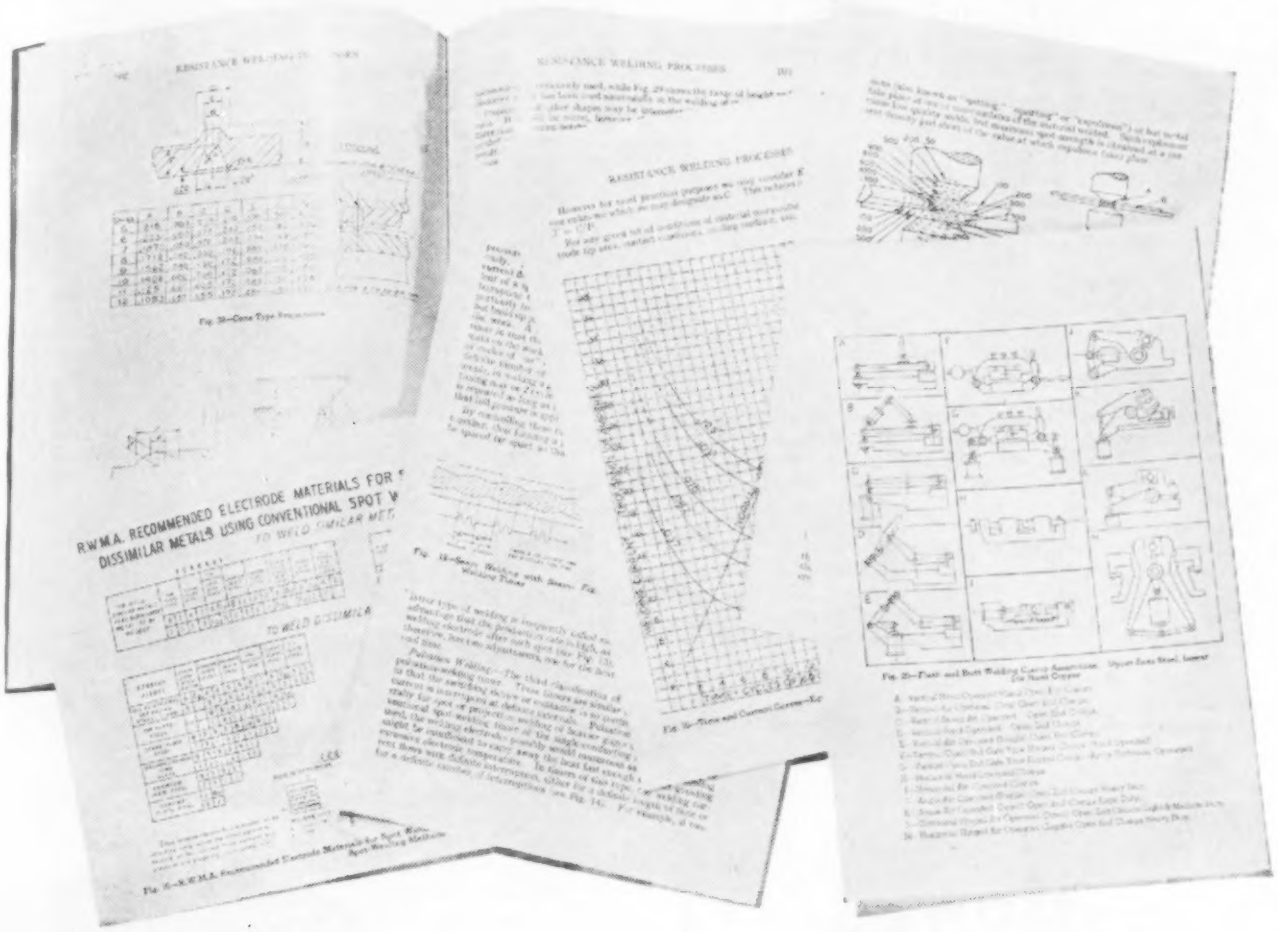

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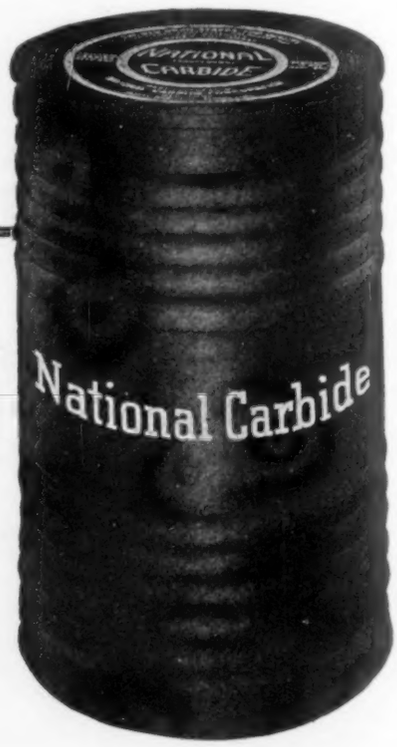

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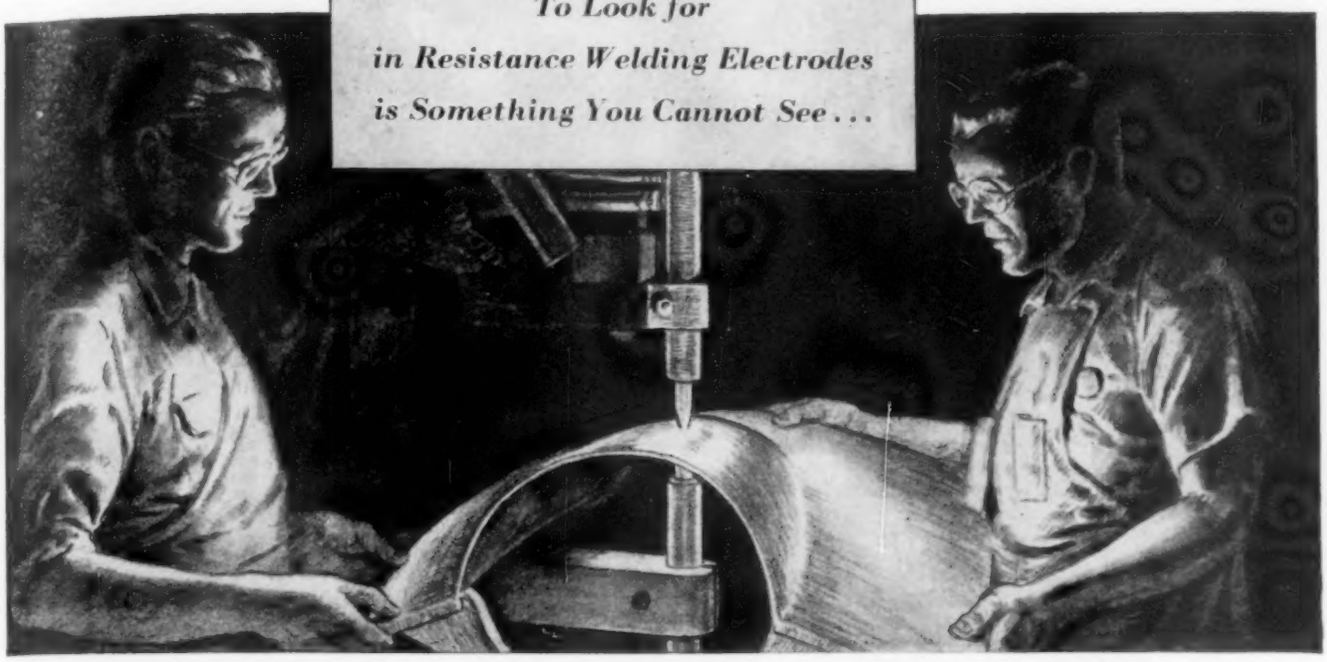

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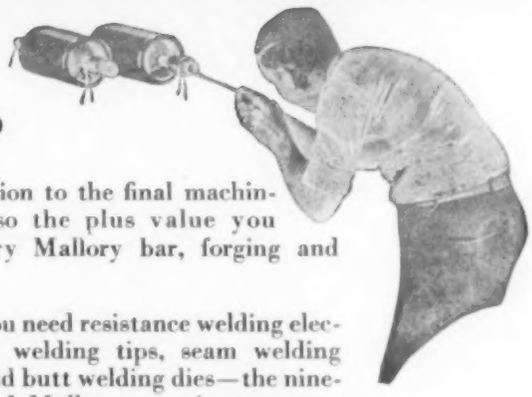

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Standard Mallory electrodes save the costly delays formerly involved in producing special tips. Mallory alloys—Elkaloy*A, Mallory 3* Metal, Elkonite*—greatly reduce "down time" for redressing and replacement.

Back of this combination of speed and excellence lies Mallory metallurgical knowledge. It extends through every step of electrode production, from the exact proportioning of the composition to the final machining. It is also the plus value you get in every Mallory bar, forging and casting.

Whenever you need resistance welding electrodes—spot welding tips, seam welding rolls, flash and butt welding dies—the nineteen years of Mallory experience are at your service. Mallory experience can help you determine the right size and contour of electrode for the job, and the type of alloy best suited for its requirements. It can lead, as it has frequently led before, to stronger, lighter, more easily fabricated products at lower cost.

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P. R. MALLORY & CO. Inc

MALLORY *Standardized Resistance Welding Electrodes*

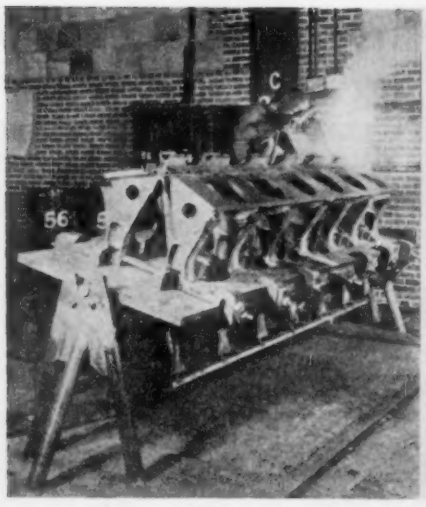


Fig. 1—Subassemblies of Diesel Engine Crankcase in Process of Fabrication. Waster Strips Shown Tacked in Position Near the Top and the Center of the Unit

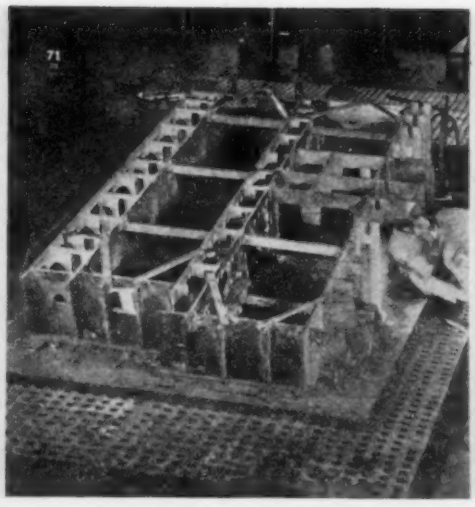
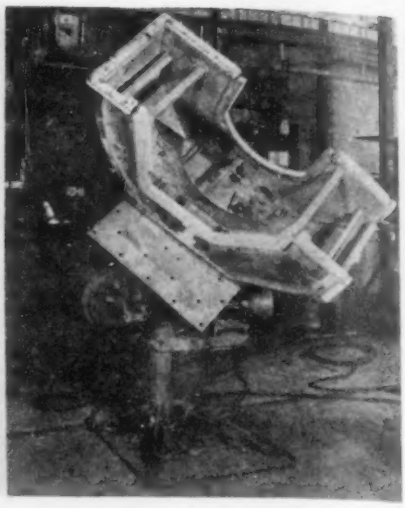


Fig. 2—Marine Gear Case in the Course of Fabrication. These Units Are Made up of $^3/_4$-, $1^1/_4$- and $1^1/_2$-Inch Plate, and Pipe. The Welds Are of the Fillet Type, Most of Them Measuring $^3/_8$ Inch



Photos Courtesy General Electric Co.

Fig. 3—Part of Gear Housing Mounted on Positioner to Facilitate Welding

A.-C. ARC WELDING SPEEDS FABRICATION OF DIESEL ENGINE CRANKCASES AND MARINE GEAR CASES

Arc welding is used almost exclusively in the fabrication of Diesel engine crankcases and marine gear cases at the Warren City Tank and Boiler plant, Warren, Ohio, according to C. U. Hansen, who is in charge of welding there. One hundred and seventy-five 500-amp. a.-c. arc welders are used for fabricating the crankcases and gear cases, a 100-amp. machine is employed in the making of templates and eight 500-amp. transformers and auxiliaries are used on production work. Only miscellaneous jobs, such as tacking waster strips into position, are done by d.-c. welding.

Absence of objectionable arc blow, quietness of operation and low maintenance costs are the major reasons why a.-c. arc welding is used so widely at this plant.

Since all of this work must meet rigid specifications, the maximum allowable deviation from standard is plus or minus $^1/_{16}$ in. in the over-all dimensions of the crankcase assemblies and plus or minus $^1/_8$ in. in the gear cases.

Welds are inspected by the Magnaflux method as work progresses, and should there be unsatisfactory welds they are repaired immediately to eliminate the possibility of work being done on assemblies that may later prove unsatisfactory. In many cases, the welds are inspected by the Magnaflux method before and after heat treatment. X-ray inspection is used extensively on the engine assemblies.

The gear cases are subjected to an additional test to insure that they are absolutely oil-tight. This consists of filling each case with kerosene and allowing it to stand for about 10 hr. In this period, kerosene will seep through the smallest opening, so the presence of a leak soon becomes evident. Any leak, is closed by rewelding, and the case is again tested.

Production of the complete crankcase assemblies has been materially aided by making subassemblies. Frequently, the design of the subassemblies permits them to be made in groups of two each, after which they are cut apart. In order to minimize distortion, each subassembly and complete assembly is welded from the center of the structure toward the end, with the work kept in balance as much as possible.

Subassemblies are heat treated separately in order to relieve stresses, after which the complete assembly is heated. Consequently, each part is treated several times during the course of production.

In addition, positioners and fixtures are used extensively to enable operators to swing the units into position for welding, so that practically all of the welds can be made in the down-hand position. Many of the subassemblies, as well as the finished crankcases are placed on the positioners in pairs, one on each side, and held in perfect balance. The positioner can then be revolved manually by the operator. This not only speeds production but results in uniform work.

Another innovation which has proved particularly helpful in maintaining uniformity is the use of waster strips tack welded to the ends of joints, which make it possible for the weld to be carried beyond the point where it is needed. The weld is started in the strip at one end and carried through into the waster strip at the other end. The strip and the part of the weld which has run into it are then removed by a torch and grinding.

AUSTRALIAN STANDARD ENGINEERING DRAWING PRACTICE

This new edition has been improved and enlarged as a result of advance in engineering drawing practice, experiences in working with the 1934 Edition, consideration of recent standards of other countries, and also as a result of suggestions obtained from a wide field of engineering opinion in Australia. At the outset of the work of revision, suggestions were invited in *The Journal of the Institution of Engineers*, Australia. Subsequently, a questionnaire was issued to Civil Engineering Authorities with a view to the inclusion of more adequate recommendations for Civil Engineering Drawing Practice. When the revision of the chapters had been sufficiently advanced, draft copies were issued in each State for comment by the Standards Association of Australia. A whole chapter is devoted to welding.

Published by The Institution of Engineers, Australia, Science House, Gloucester and Essex Sts., Sydney, N. S. W. Price $2.00.

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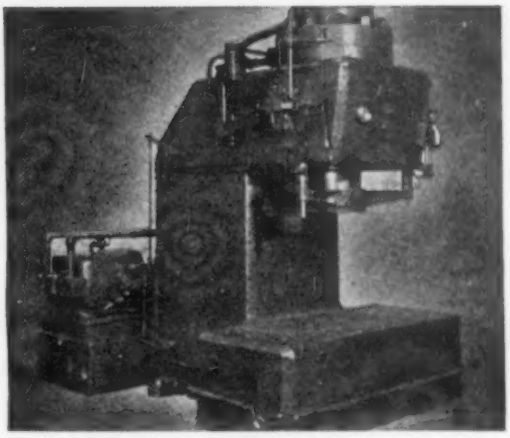
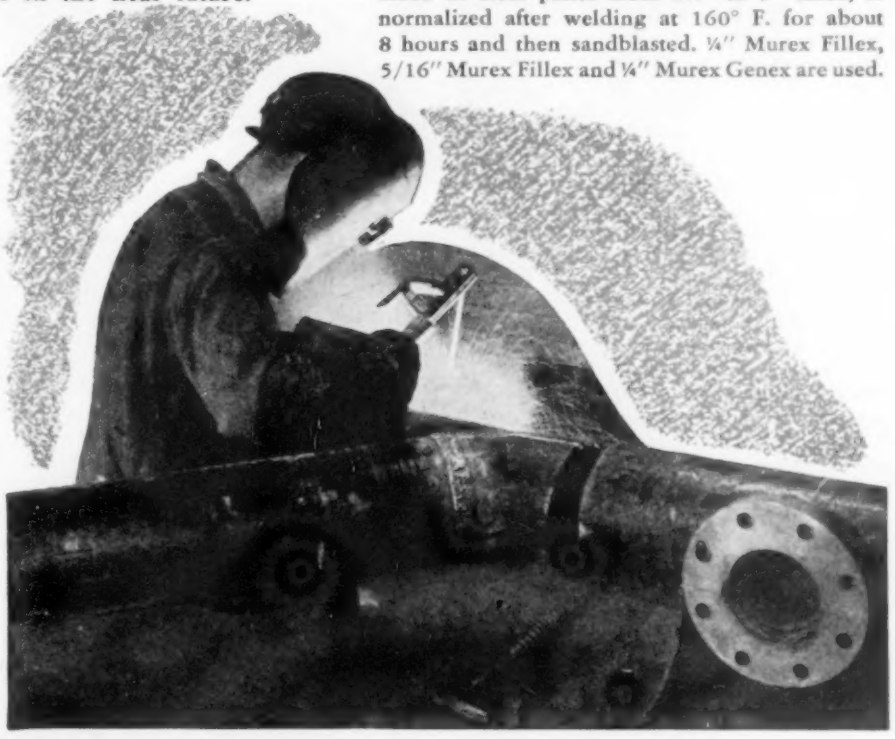
THE QUANTITY PRODUCTION of electrodes to meet the requirements of war production has been, of course, our chief concern. Research and development work has not been neglected, however, and a continuous program devoted to the improvement of present electrodes and the creation of new ones is carried on continuously at our modern research laboratory in Woodbridge, N. J.

As a result of this important work, announcements of several new Murex electrodes will be made in the near future.

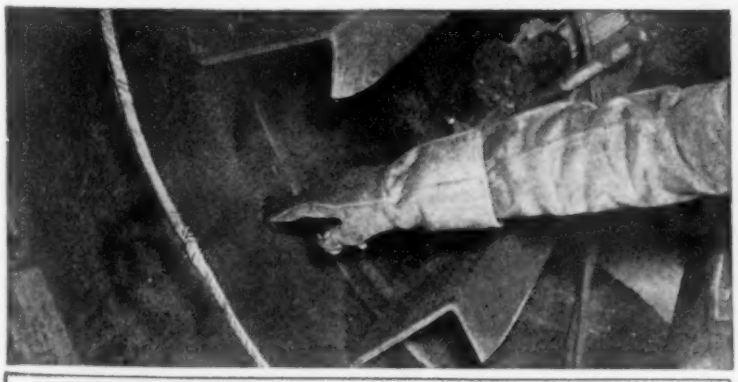


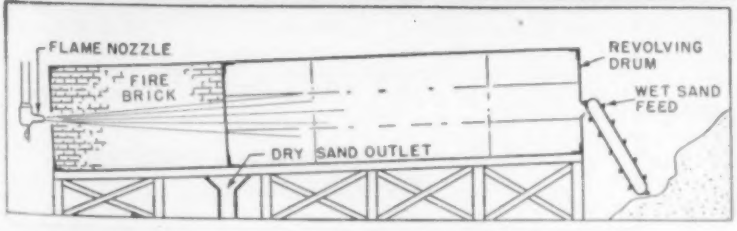
OILGEAR SPECIAL 200-300-TON GOOSENECK PRESS for straightening large, long tubes. Welded frame is made of steel plates from 1½" to 5" thick, is normalized after welding at 160° F. for about 8 hours and then sandblasted. ¼" Murex Fillex, 5/16" Murex Fillex and ¼" Murex Genex are used.

ERECTION OF A 30,000-TON UNIT SYNTHETIC RUBBER PLANT, one of six built by the Blaw-Knox Company, required approximately 11 miles of piping ranging in size from 2" to 30" which called for over 26,000 welds. These piping systems required designs for a wide variety of conditions, such as high pressures and temperatures, refrigeration, vacuum, hazardous liquids, gases and corrosive chemicals. Murex electrodes were used.



(Below) WELDS IN SAND DRYER WITHSTAND HEAT EXTREMES AND ABRASION. 450 tons of sand pass through this revolving dryer cylinder during eight hours' operation at red heat temperature which sometimes drops below zero after shutdown. Welded with Murex Molex electrodes, the welds outlast the dryer's half-inch steel liner plates. The liner plates are made in three segments, with a girth weld and 3 horizontal welds for each section.





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Welding Helped Make the President's Car Safe for the Cairo Conference—and Quickly, Too*

By Fred B. Barton†

ONE of the most exciting safety stories of the war can now be told. It deals with the personal appearance of the President of the United States at a point not far from the European fighting fronts, and in a territory still loaded with Nazi and even Jap sympathizers.

The event was the famous Cairo conference at which military chiefs of the Allied nations met and talked together. President Roosevelt was there for three weeks. So was Prime Minister Winston Churchill of Great Britain. It was not long after this conference, and the one at Teheran which followed immediately after, that General Dwight ("Ike") Einsehower was named supreme commander of the Allied invasion forces in Europe. After Cairo and Teheran the war shifted into high gear.

Now that it is safely over, it can be admitted that this trip was a tremendous risk. Mr. Churchill developed pneumonia, but recovered after a rest in Marrakech in French Morocco. Mr. Roosevelt's C-54 plane made the trip over and back safely. Wisely, a small squadron of escort planes flew alongside to render any aid that might be necessary in case of a forced landing on land or sea or—we don't even like to think about it—to ward off enemy planes in case of an attack.

At the Mena House on the edge of Cairo, Egypt, a company of U. S. soldiers moved in and stood 24-hr. guard. WAC telephone girls, fresh from the States, took over the switchboards. And secret service men, in and out of uniform, quietly took charge.

The President's car was given special attention. He stayed for those three weeks at xxxxxxxxxxx‡ Egypt, and rode around Cairo a little as well as to and from the conferences at the Mena House—

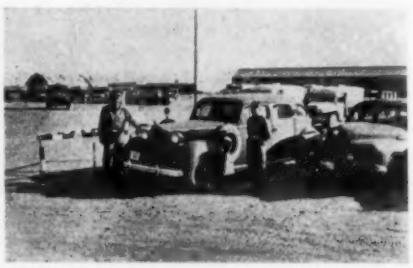

Fig. 1—Ordnance Lieutenant L. I. Wilkinson of Gulfport, Miss., and His Jeep Driver, Corporal T/5 Fred Beers of Jeannette, Pa., Alongside the Armored Packard Rebuilt to Make a Bullet-Proof Car for the President's Visit to the Cairo Conference Last November

the big hotel with private swimming pool and golf course which overlooks the Pyramids. The President never moves, especially in unfriendly territory, without a motorized guard before and behind. But even so, Secret Service wanted to take no chances. It aimed to provide President Roosevelt with a car which would be both a comfortable sedan and also a floating fort.

Ordnance Lieutenant L. L. Wilkinson of Gulfport, Miss., Technical Director of a Base Automotive Maintenance installation stationed on the edge of the desert near Cairo, Egypt, tells the story.

"It was Monday, November 15, when the secret service brought around the sedan and asked us if we could make it thoroughly bulletproof and bombproof," he says. "They asked for the job in a hurry. We could have not more than four days. Three would suit them even better.

"The car was a 1937 Packard, a standard U. S. Army style and color of paint. The outside we didn't touch a bit; it didn't need any distinguishing marks. The driver's seat we didn't touch, either.

"But from the partition on back we ripped out everything carefully, upholstery and cushions and even the window glass, and went to work.

"We had no pattern to work by, but we had a definite idea of what was wanted. Protection first. That meant shielding the cab from any chance bullet from side or top or back, or from even an explosion from the bottom. But we had to leave the windows clear. The President wanted to see and be seen. We had to give him an armored limousine, not a black-out car.

"We made our patterns out of paper first and then plywood. Then we cut armorplate to fit, and stitched it in.

"It was a day-and-night job. During those three days we kept our welder running 18 hr. a day."

Fig. 2—A Ford Truck Made Over Into an Auxiliary Locomotive by Welding

The armor plating was the stuff developed at Rock Island Arsenal and used to protect the nose of a P-38 or P-40 from bullets. It has been frequently tested at Aberdeen Proving Grounds, back home in Maryland, and also on many a pursuit plane in the present war. Fortunately it was not put to the test in its job of shielding the President of the United States from harm.

As much as possible the protection was kept concealed and the whole job made neat and inconspicuous. Except for the weight and thickness of the doors when you climb in you are scarcely conscious

* Article and photos supplied through the courtesy of the Lincoln Electric Co., Cleveland.
† War Correspondent.
‡ Deleted by U. S. Military Censor.

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In a recent independent production test with 13 other processes, aluminum treated by the Diversey Process averaged 930 spots before tip fouling. All shear test requirements were easily met. Results . . . checked and rechecked by technicians in the plant conducting the test . . . definitely established the excellence of the Diversey Process.

The Diversey Process involves two simple steps:

1. Removing all foreign matter from the surface with Diversey Aluminum Cleaner, a dry, white powder, easily used in still tank cleaning, whose powerful cleaning action is inhibited to prevent pitting, staining or discolorations.
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It has been definitely established that the production of consistently sound spot welds is, in part, a function of the surface treatment. The presence of oxide film and its attendant high electrical resistance cause irregularities that affect the uniformity and quality of the welds. Aluminum test strips treated by the Diversey Process show no "water breaks," indicating a chemically clean surface . . . while surface resistance averages as low as 12 microhms.

Today the Diversey Process is in use in many large aircraft and other plants throughout the country . . . consistently giving quality spot welds with greatly increased tip life. For further details send for free technical bulletin No. 501. Address Metal Industries Dept. W4,

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that this car has been built over. The armor plating was welded in place, which was neat enough. Then the upholstery was put back and fastened, so the back seat would again be comfortable.

A small blower was built in to keep the air circulating, because the rear window was sealed over and the front and side windows covered with tight-fitting chunks of bulletproof glass.

From the outside the windows look about the same. Inside, however, the iron brackets supporting the heavy glass—welded in place, of course—could not be concealed. After all, this was a matter of miltary safety; not something to do with a lady's boudoir. The brackets were a sturdy black iron. They were neat but not handsome.

The welders finished their job on time, of course, and a little ahead of time. While the shop was at it, they built in extra spring-leaves to support the many hundreds of pounds of extra weight represented by the armor plating. The car now rests in quiet dignity in an Army parking lot at Camp Huckstep, outside of Cairo. If driven over the roads with its new weight the car would not last long. Nor may it be worth the Army's while at this moment to tear out the welded armor plating (a job for cutting torches) and rebuild the inside all over again.

They don't get a President's chariot to rebuild every week, but these men of the Base Automotive Maintenance installation handle a lot of strange war jobs. They have learned to improvise and to do a finished job without very much to start with.

That is where arc welding very often helps. The other day, for instance, they had to put a water tank on a trailer body. The trailer chassis wasn't long enough for the new load. It needed an extra 6 in. So they cut off new pieces of channel iron to length and welded them in place, with a stout over-riding length of steel welded alongside to furnish still further strength. A job like that is done quickly. The rest of the body building moves along without delay.

Another unusual welding job was the building of an auxiliary locomotive to push railroad cars around. A Ford truck was built over, a pusher being put on in front. The rims and tires were removed and the hubs corrected so as to ride the rails. This "locomotive" can pull or push three loaded freight cars. It is a handy thing to have around in case the tiny steam switching engine ever goes sour again.

Chassis repairs have been made on all sizes of trucks used by both the American and British fighting forces in North Africa. The booms on auto wreckers likewise were welded in place here.

A further small but important product of this shop is the hundreds of glare-proof headlight shields for trucks, built to prevent a truck from being seen by enemy planes at night.

Some of the American soldiers handling welding jobs in this desert repair shop are new to welding. But they handle the welder like experts. In fact, in keeping with the Army's policy of using civilian personnel where possible, as a gesture of friendship, this shop has not only trained green G-I's (enlisted men) but also has brought in native Egyptian labor and trained them. The soldiers set up the work and the civilians do it.

MATERIALS AND PROCESSES

Materials and Processes, edited by James F. Young, Engineering General Division, General Electric Company, Schenectady, N. Y.

This book has been written to present in one volume a broad study of the materials and manufacturing processes employed by the design engineer, and thus to provide information directly useful in the selection of materials for design. The book is intended for convenient reference and for textbook use. It has therefore been organized for ease in classroom presentation and in such a manner as, it is hoped, will give the practicing engineer or designer an over-all picture of the subjects discussed. This textbook considers chiefly the materials and processes used in manufacturing electromechanical products. Sufficient metallurgy is included to enable the engineer to understand heat-treating practice and the effects of various processes on metallic materials. A chapter on welding is included.

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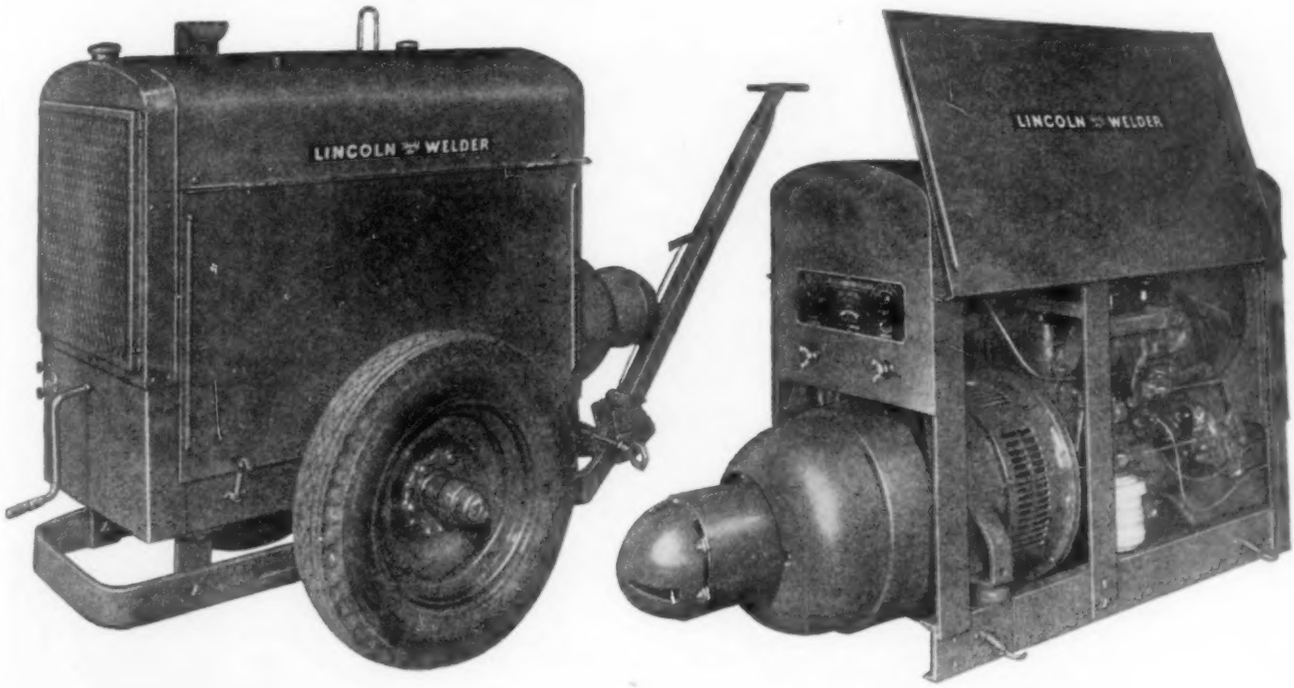

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ARC WELDING

TIPS ON THE CARE AND MAINTENANCE OF PRODUCTION RESISTANCE WELDING EQUIPMENT

By E. R. Spittler*

RESISTANCE welders are an essential part of a plant's machine tool equipment. Consequently, they should be given the same consideration and careful maintenance as a milling machine, lathe or any other preisicon machine tool.

Both welding quality and production requirements are so exacting today that no part of resistance welding equipment can be expected to deliver the proper standard or quality of work if it is in need of repair or adjustment. A regular schedule should be maintained whereby a periodic inspection can be made for parts that need replacement.

Obviously the object of this short article is not to give detailed recommendations on the proper maintenance procedures, but rather to point out those units that require special attention. Excellent detailed information on the installation, inspection, maintenance and trouble shooting of individual units can be obtained from manufacturers.

Transformer

If the welding transformer is water-cooled, be sure that free circulation of water takes place at all times during the operation of the machine. Remove all dirt, dust and grit from the transformer and secondary circuit at least once a week (Fig. 1). An accumulation of flash particles will cause a short circuit in the transformer winding, thus reducing its efficiency, increasing operating costs and eventually causing the transformer windings to burn out.

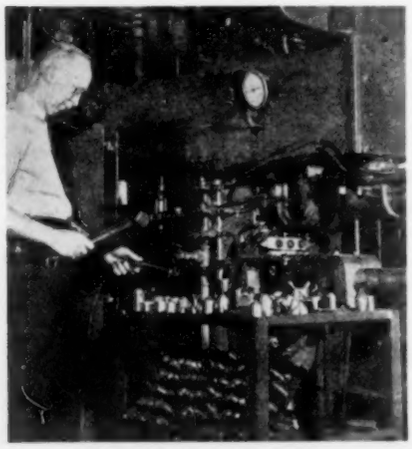

Fig. 1—Welding Transformer of Spot-Welding Machine, Being Cleaned

Switches, Contactors, Timing Devices

These are the nerve centers that control the operation of a welder and, consequently, must always be in good condition, mechanically and electrically, to assure efficient operation. They should be checked every two months for evidence of wear, such as oxidation at fuse connections in switches, loose electron tube sockets and loose wiring in timing devices (Fig. 2).

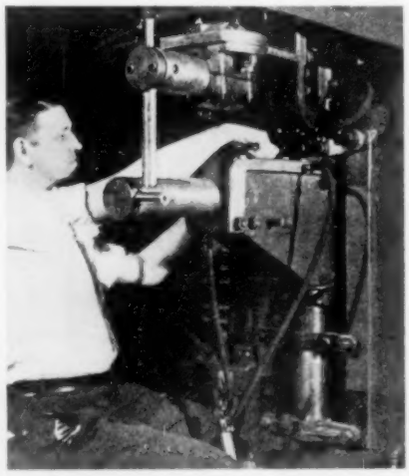

Fig. 2—Joints of Secondary Electric Circuit Being Tightened on Spot-Welding Machine

Electrodes or Dies

Electrodes, welding wheels, dies or mandrels that have become burned or pitted with steel are a constant source of trouble. Frequently refacing the working surfaces of these electrodes is excellent insurance against poor welds (Fig. 3).

Fig. 3—Working Surface of Circular Disk Electrode (for Seam-Welding Machine) Being Refaced on Lathe

All electrodes and welding dies should be cooled by some method. If water is used as a cooling agent, a full flow should always be maintained while the machine is in operation.

Clamps and Fixtures

The accuracy of the welded assembly can only be as good as the fixture holding it in place during the welding cycle. It is evident that close inspection and frequent adjustment of the fixtures must be made.

Motors and Drives

Motors, variable-speed drives, clutch and reduction units, and transmission gears and shafts, being essential to the proper operation of the welder, should be inspected and adjusted or overhauled as often as necessary, the frequency depending on the production load.

Oiling

All moving parts must be oiled and greased at regular intervals to assure smooth, even motion and minimum wear (Fig. 4). Avoid dropping oil or grease on any of the electrical wiring or connections.

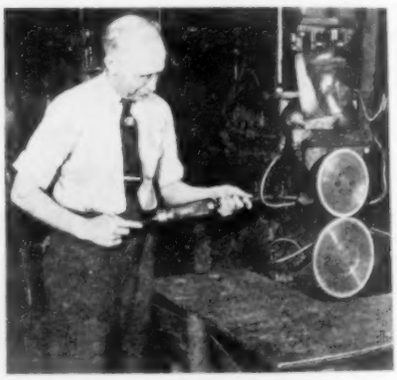

Fig. 4—Seam-Welding Machine Being Lubricated

Pressure

All welding machines have some device for establishing welding pressure. Usually this consists of an air or hydraulic cylinder, or a cam or toggle with spring arrangement. This system should be inspected periodically and kept in perfect condition at all times. All air and oil filters should be cleaned at regular intervals.

VICTOR APPARATUS BULLETIN

An attractive Victor Apparatus Bulletin has just been issued.

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NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

COATED ALUMINUM-BRONZE ELECTRODE

The Air Reduction Sales Co. announces a new Coated Aluminum-Bronze Electrode—AIRCO No. 100. This new coated high-tensile bronze electrode is a shielded arc electrode, and can also be used as filler rod in carbon arc welding. It will produce welding deposits of great strength and hot ductility, combined with desirable resistance to corrosion.

Deposits made with the electrode are superior to standard manganese bronze with respect to corrosion resistance, and are equal to it in strength, hardness and ductility.

The AIRCO No. 100 has a most universal application in the welding of most bronzes, malleable and cast iron or steel. In addition, it has other specific applications for which it is especially suited, such as welding manganese bronze conforming to Federal Specifications QQ-B-726b, or Navy Specifications 49-B-3e for Marine Propellers and other parts where great strength, ductility and corrosion resistance are strict requirements.

The electrode can also be used for welding dissimilar metals, such as cast iron to brass, steel to malleable iron or the joining of any two metals which are weldable with aluminum bronze.

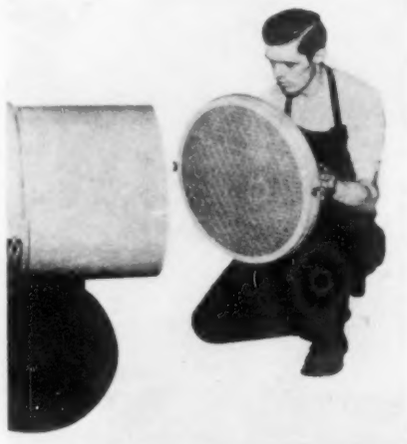
Sizes from $^1/_8$ to $^3/_{16}$ in. in 14-in. lengths and $^1/_4$ in. in 18-in. lengths are standard stock items. Sizes from $^5/_{16}$ to $^1/_2$ in. in 18-in. lengths may be procured on special order.

The new AIRCO No. 100 Coated Aluminum-Bronze Electrode is available through offices of the Air Reduction Sales Co. and their authorized distributors.

AIR FILTER PROTECTS D.-C. GENERATOR WELDERS FROM DUST

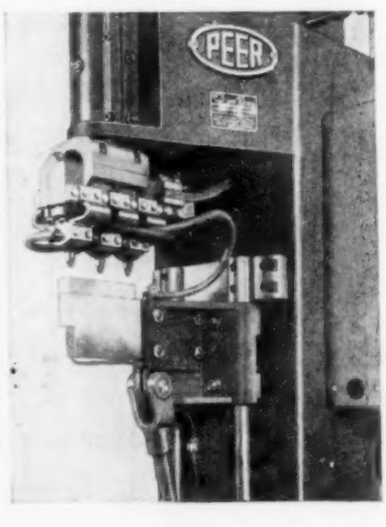
A new permanent, all-metal, air filter that saves time and money on all d.-c. generator welders and similar valuable machinery and equipment that is exposed to the scourge of process and air-borne dust, has just been announced by Air Devices, Inc., 17 East 42nd St., New York 17, N. Y. Designed especially for quick, easy installation on all standard types of d.-c. generator units, the impingement type filter unit traps all dust particles before they can reach rotating parts of the equipment. On any similar motor or generator installation, it doubles brush life, and prevents "frozen" or clogged rotor which often cause expensive repairs and lost production time.

Filter medium is of the permanent type, with high dust-holding capacity, low air resistance even when heavily dust-laden, and high filtering efficiency. Encased in arc-welded steel frame, it can be removed easily for quick cleaning. Welder filters are available in sizes to fit all standard welders, and in standard or special sizes adaptable to any machine or equipment.



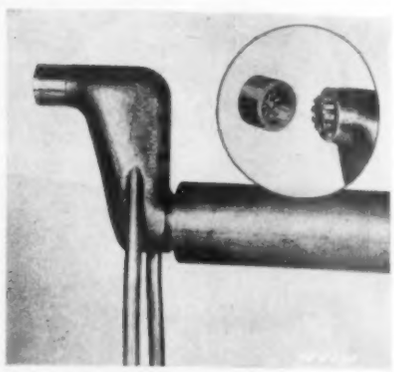
MULTIPLE ELECTRODE WELDING

During the last few years there have been many cases of assemblies requiring a number of spot welds within close proximity For such work fabrication has been speeded up and greater economy attained through the use of hydraulically equalized multiple spot-welding electrode units. One of these heads, a 3-point unit, is shown employed on a Peer press type welder. This head made it possible to reduce the number of operations on a metal box requiring 52 spot welds to 14 operations. Accuracy of spacing was easily accomplished and the pressures held uniform by the hydraulic equalization provided in the head. For detailed information regarding this type of welding equipment, write the Pier Equipment Mfg. Co., 2000 Milton St., Benton Harbor, Mich.



OFFSET ELECTRODE PERMITS TIP COOLING

The first offset spot-welding electrode which can be effectively cooled at its tip has been announced and made generally available by Frostrode Products, 19003 John R St., Detroit 3, Mich. Large numbers of this new type of electrode are already being used in the fabrication of aircraft subassemblies.

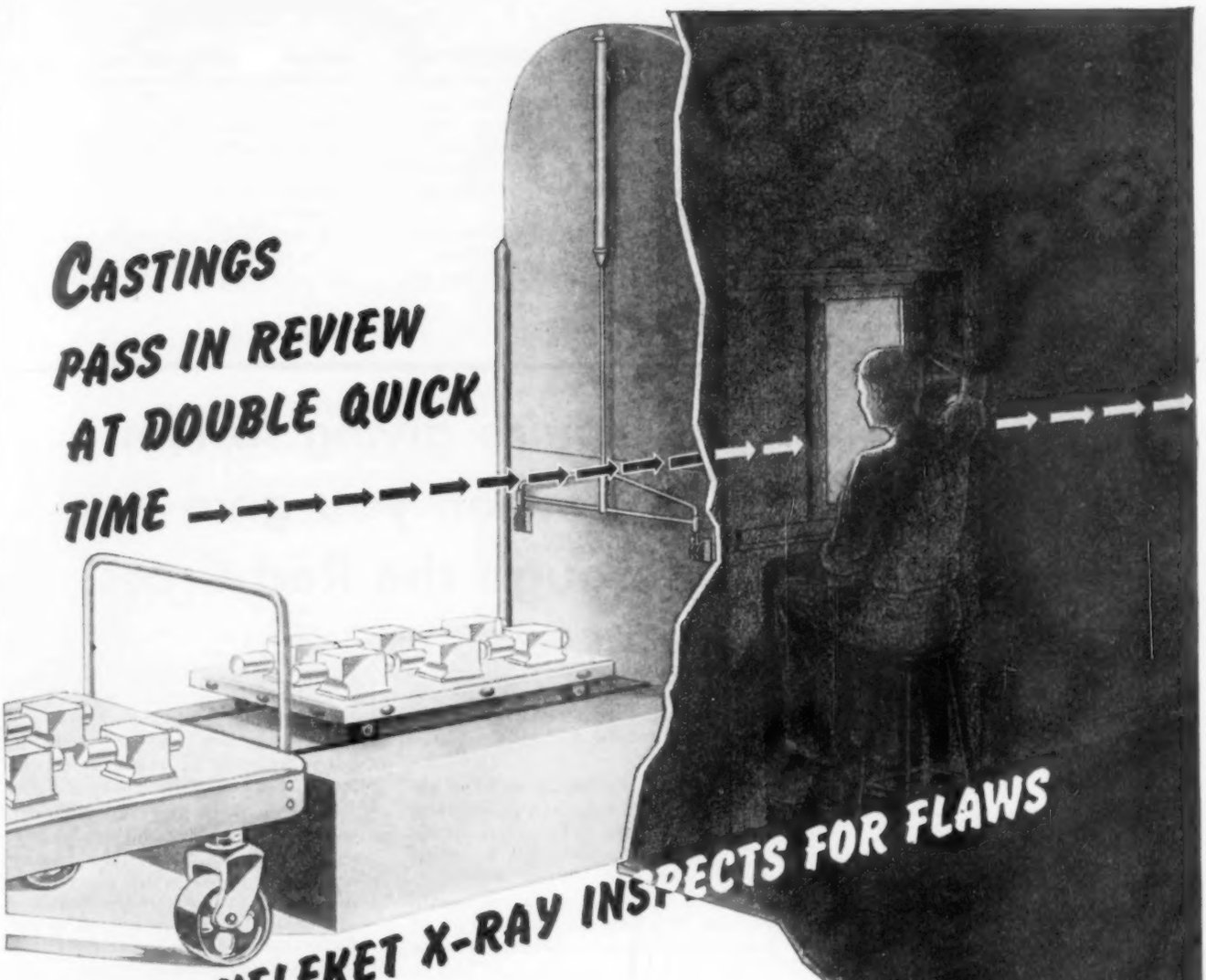


"Frostrode" Offset Electrode Installed in a Standard Electrode Holder. Inset Shows Replacable "Frostcap" and Internal Coolant Guide

Until the development of this offset electrode it was impossible to provide efficient electrode cooling, it is claimed, when spot welding in such hard-to-get-at positions as spots close to flanges, etc., since internal water passages could not be extended to the tip without dangerously weakening the "knee" which the offset type of electrode requires. Maximum strength in the Frostrode offset electrode is retained by having a "solid" cross section at the point of greatest stress. The cooling liquid enters the Frostrode offset electrode below the knee and thence flows through the coolant guide into the finned, replaceable "Frostcap" which forms the electrode's tip.

The new offset electrode is adaptable to any standard electrode holder. It is available with either a $^5/_8$, $^3/_4$ or a $^7/_8$-in. O.D. replaceable Frostcap of hard drawn copper for high conductivity or Mallory 3 Metal for high hardness. The shank may have a No. 2 or larger Morse taper. Offset distances of from 0 to 4 in. are available. Vertical clearance $1^3/_4$ in. minimum.

Make Your Reservations Now for the Annual Meeting

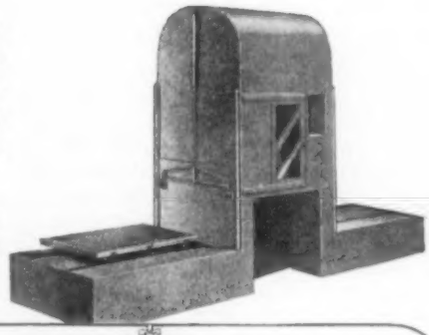


Have you explored the possibilities of inspecting castings *in mass production*—of looking inside of every casting, at rates as high as 800 per hour?

You can do exactly that with the KELEKET Combination Fluoroscopic and Radiographic Unit. Production is faster—inspection is closer—and you don't have to destroy *any* casting to inspect *all.*

You can inspect either fluoroscopically or radiographically with this combination unit. Fluoroscopy has the advantage of greater economy, as it eliminates all film, chemical and processing costs. And its sensitivity exceeds 5%. The radiographic method gives you a permanent record and may be used for inspecting large, heavy parts which do not lend themselves to the fluoroscopic method.

KELEKET offices are situated in 64 cities. Phone the office nearest you—or write direct to Covington for full details on this high-speed, KELEKET X-ray inspection unit.



ARMY E NAVY

KELLEY-KOETT X-RAY MFG. COMPANY
2184 WEST FOURTH ST., COVINGTON, KY.

PIONEER CREATORS OF *QUALITY* X-RAY EQUIPMENT SINCE 1900

SPACE-SAVER TOGGLE CLAMP

A recent addition to the De-Sta-Co line is a small, light duty toggle clamp with a T-shaped handle, which has been found to increase efficiency of operation in spots where limitation of overhead space prohibits the use of the larger or taller clamps. In those places the T-handle provides a firm grip which would be impossible to secure with a shortened straight handle of the standard type.

Dimensions are 3 7/8 in. from end of work bar to end of base and 4 in. high overall when in locked position as illustrated.

Full information will be sent on request, by Detroit Stamping Co., 322 Midland Ave., Detroit 3, Mich.

CURRENT INTERRUPTOR FOR INDUCTIVE D.-C. CIRCUITS

The Dynatrol, a new device for the high-speed, arcless current interruption of inductive d.-c. circuits has been announced by Sciaky Bros., 4915 W. 67th St., Chicago 38, Ill. The Dynatrol is designed to replace magnetic contactors formerly used on resistance welders of the electromagnetic stored energy type. While these contactors proved effective, the continuous arcing required periodical maintenance and replacement and resulted in some power loss.

The Dynatrol interrupts the charging current without arc and thus reduces maintenance, increases the efficiency of the system and, because of shorter charging time, results in 20% greater operating speed. It is essentially a high-speed, single-pole interruptor, the contact points of which are shunted by a bank of capacitors. The movable contacts open with a very high acceleration—so that at any instance they have separated sufficiently to prevent a discharge while the primary current is directed to the capacitors.

The Dynatrol is available on all Sciaky stored energy welders up to and including 50 kw. Write for descriptive Bulletin 201-A.

X-RAY INSPECTION INCREASING

The great importance of X-ray inspection of castings and parts has been recognized in the production of war materials. This is particularly true of vital aircraft parts where it is a matter of life and death if a part should fail while in service because of some hidden flaw.

X-ray inspection reveals flaws which can seldom be detected by ordinary inspection methods. A great many Aircraft castings and parts of a vital nature are now being X-ray inspected to be sure they are perfect.

The Air Forces, particularly, have demanded X-ray inspection and in order to keep up with the great volume of X-ray inspection work, the Claud S. Gordon Company are adding to their facilities an additional X-ray Unit which it is planned will be used exclusively for inspection of aircraft castings.

You're giving to him when you give through the Red Cross!

ELEVEN million men in the services—but one alone whose name you never forget—one alone for whom you would do anything, give anything.

Through every dreary day you are buoyed up by thoughts of *him*. The long, lonely nights are a little less lonely when you can read *his* letters, see his picture upon your bedside table.

And yet there is so little you can do for him. If only you could be sure of helping him when he needs you most.

But you *can* be sure. For you give *to* him when you give *through* your Red Cross.

Wherever he may be in camp or abroad, in desert, in jungle or icy waste, the Red Cross is at his side. Your Red Cross is there with "coffee and" when he finishes a long march.

Your Red Cross is there when he is lonely and lost in some strange city on leave.

Your Red Cross provides hostels, canteens, "a bed with clean sheets," cheer, comfort and companionship for him no matter where he may be.

Well or wounded, your Red Cross is at his side. The blood you gave goes to him, thanks to your Red Cross. His convalescence is made easy with Red Cross books and games and gifts.

Even should he be a prisoner of war, your Red Cross will still reach him. It will get your letters in to him, get his letters out to you. And every week, straight from your heart, the Red Cross will bring him eleven pounds of real American food and real American cigarettes and tobacco.

Wherever he is—wherever he may go—he will never be out of your reach. For you give to him when you give through the Red Cross.

* * *

Of course, you have given before. Of course, you will give again.

But this year when the need is greater than ever... when it's your own men we serve... this year dig deeper than ever before and be glad that you can. For wherever he is

The RED CROSS is at his side
***and the Red Cross is* YOU!**

THIS SPACE CONTRIBUTED BY THE PUBLISHER

X-Ray on wheels

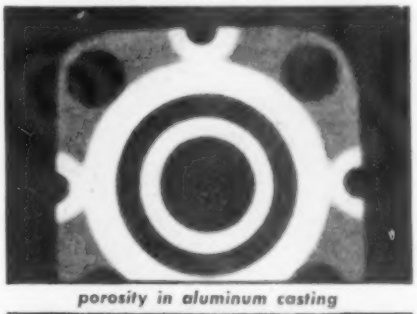
this powerful Mobile 150 KVP X-Ray Unit brings non-destructive x-ray inspection to any part of your plant.

"ON THE SPOT" RADIOGRAPHY The Picker 150 KV Mobile Unit brings comprehensive facilities for X-Ray inspection directly to any point of production in your plant.

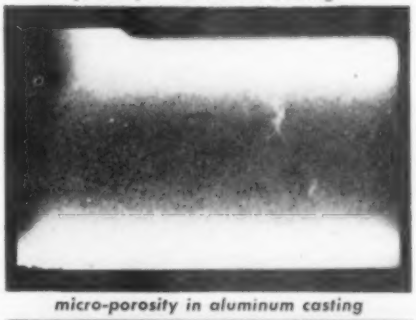
This compact, powerful, easily transportable apparatus fulfills every requirement for production inspection or spot checking of many diverse materials . . . metals, plastics, fabric, wood. Completely self-contained, requiring only a current source, the Picker 150 KV Mobile Unit provides positively controlled voltages from 15 KV to 150 KVP, with a radiographic capacity (with screens) up to 1½" of steel and 7" of aluminum. The rapidity of exposures ideally adapts this Unit to consecutive production inspection.

Write today for our bulletin on the Picker 150 KV apparatus, which gives details of construction, capacities and applications. Our engineering staff and research bureau is at your service for the study of any special problems concerning non-destructive radiographic examination.

Some typical examples of defects disclosed by non-destructive radiography



porosity in aluminum casting



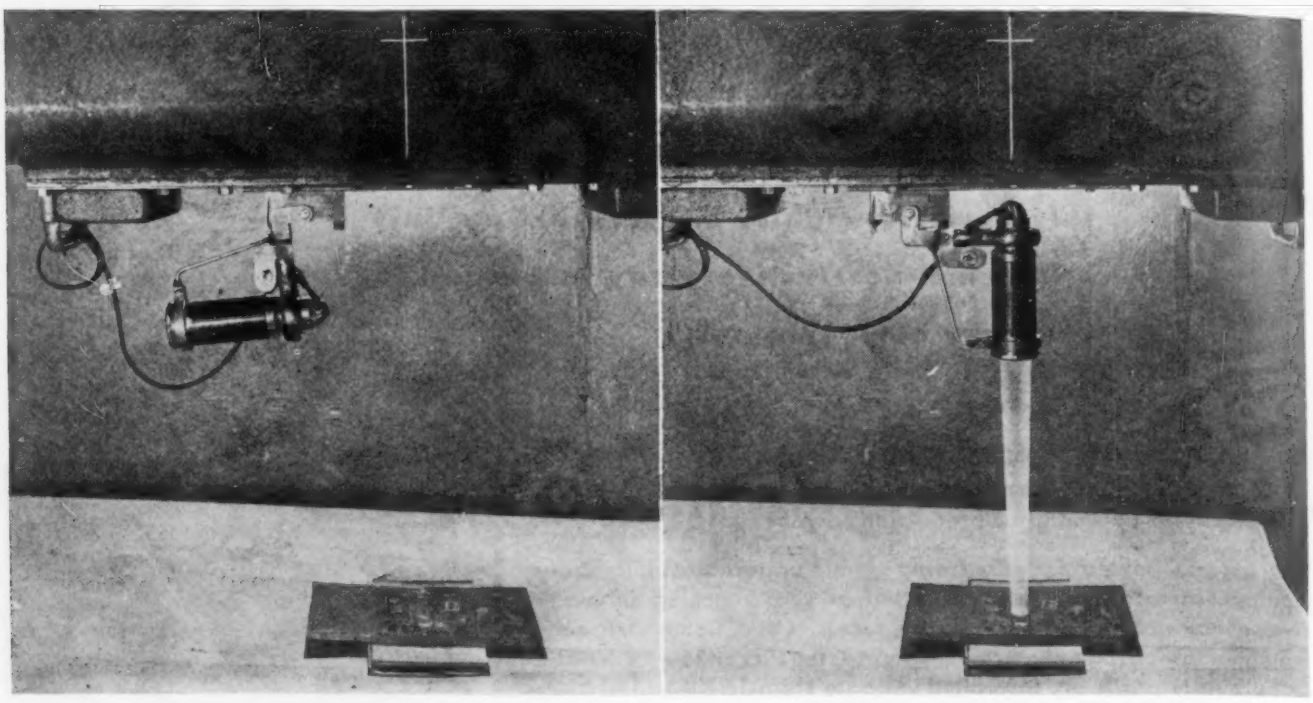
micro-porosity in aluminum casting

gas inclusion in steel

PICKER 150 KV
MOBILE X-RAY UNIT
Capacity 10 milliamperes at 150 KV continuous

PICKER X-RAY CORPORATION
300 FOURTH AVENUE • NEW YORK 10, N. Y.
WAITE MANUFACTURING DIVISION
CLEVELAND • OHIO
PICKER X-RAY OF CANADA, LTD.
MONTREAL • TORONTO

First "E" Award in the X-Ray Industry



Targeting X-Ray Head

TARGETING X-RAY HEAD

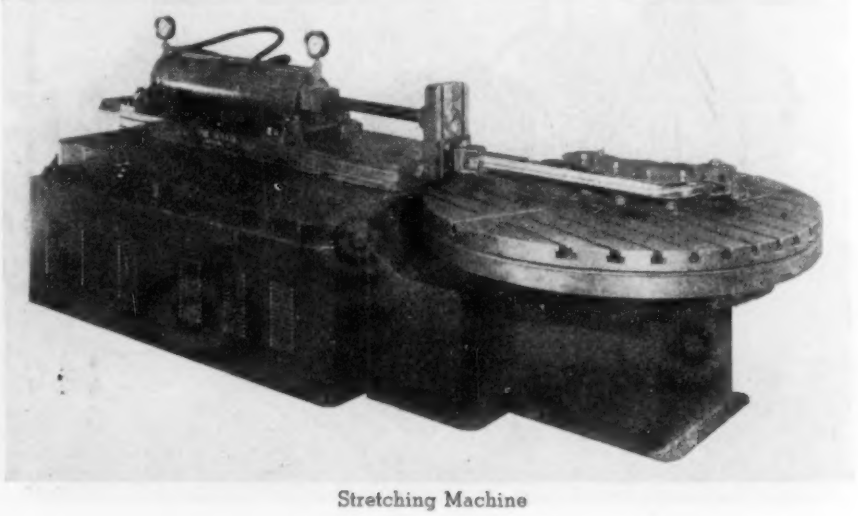
The accompanying photographs show the installation and operation of a special spotlight for targeting on X-ray head used in production X-ray work. This light, designed by W. C. Cadwell of the Caterpillar Tractor Co., has saved much time in targeting the X-ray beam for miscellaneous shots on welded assemblies as well as greatly improving the uniformity of duplicate radiographs of the same area by eliminating the variable in positioning the X-ray head.

The light arrangement consists of a "Spotfinder" flashlight tube mounted on a hinged bracket so that all parts may be swung out of the X-ray beam during an exposure (as shown in the photograph). The light source is a 3-cell flashlight bulb connected to 6-v. a. c. and through the lens system, a light beam is formed with a focal point several feet from the X-ray head. This beam gives a light spot about $^3/_4$ in. diam., 30 in. from the head.

In operation, a setup for a given shot is made by first setting the head to the proper angle, as indicated by a protractor mounted on the head, next raising or lowering the head to the proper tube-to-film distance and third locating the X-ray beam, by means of the target light, to the center of the film area. In cases where a given assembly is X-rayed, in several areas all of which are in the same horizontal plane, the setup is still simpler in that only the head angle and light spot position have to be set. The light has been particularly valuable in X-raying confined areas where adjacent parts may block out part of the X-ray beam as the light beam coincides with the X-ray beam and any interference can be noticed in the setup.

STRETCHING MACHINE

The Cyril Bath Co. of Cleveland, manufacturers of universal stretch presses and the contour forming machine have developed a semistandard stretch head for use in connection with stretch forming presses. These stretching machines are welded construction. The casing of the head is made in various sizes and may be fitted with jaws giving either two, three or four angular sliding movements, so arranged as to grip almost any shape evenly and over the maximum amount of surface. These heads can be adapted to pulling either extruded shapes, brake or rolled sections, or flat sheet work, and have been used successfully on all grades of aluminum alloys and stainless steel. In the smaller sizes the jaws may be hand released, in the large sizes either air or hydraulic cylinders do the initial clamping and release work. Considerable research has been put on the development of these heads, the manufacturer feeling that the stretch forming process depended largely on a reasonably low cost stretch head and one that would operate quickly and with a minimum grip on the stock and a minimum of work spoilage. Figure 1 shows a typical set of heads as adapted to an extrusion. Figure 2 shows a Bath Universal Rotary Stretcher forming a tank strap in which the leg of the angle must stay in the horizontal plane, while the flange changes in angularity as much as 15° from one end to the other. The jaws are so constructed that different inserts can be readily adapted to accommodate different shapes. The jaws are loaded simply by pushing the material in and unloaded by pulling the release handle forward and then removing the stock.



Stretching Machine

Industry's big Swing

to the WILSON "BUMBLE BEE"

HAS BROUGHT AN UPSWING in WELDING PRODUCTION

IF you want to increase welding output by 15 to 30%—and reduce power costs by 30% or better — join the growing number of plants that have changed to the Wilson "Bumblebee" AC welder.

Shipyards, aircraft plants, steel fabricators and metal-working shops of all types are finding that the "Bumblebee" permits faster welding with better quality welds than DC machines of equivalent capacity (particularly on deep grooves or corners). In addition, its built-in capacitors provide better power factor, which relieves overloaded power lines as well as lowering power costs. Maintenance time and costs are lower, too, since the "Bumblebee" has no parts which move or rotate during welding.

Made in 300 and 500 ampere capacities, the "Bumblebee" is available in standard and All-Weather types. Special running gear can be supplied (at slight extra cost) where portability is desired. Wilson AC welders are made in sizes from 100 to 1000 amperes capacity. Write for free Catalog ADW-53 for detailed description — use the coupon for convenience.

FOR TOP FLIGHT AC WELDING WILSON 530 AC ELECTRODE

Perfect teammate for the "Bumblebee" is the all-position AC electrode—Wilson No. 530. It produces high quality welds that conform to these specifications:

AWS Filler Metal, Spec. E6011

Navy Bureau of Ships, Spec. 46E3, Grade III, Class I

A.S.M.E. Boiler Code, Para. U68

American Bureau of Shipping

WILSON

WILSON WELDER and METALS CO., INC.

General Offices: 60 East 42nd Street, New York 17, N. Y.

In the U.S.A. WILSON AC WELDERS—distributed through the Air Reduction Sales Company

In Canada: G. D. Peters & Co. of Canada Limited, Birks Building, Montreal

Send for free Catalog

WILSON WELDER & METALS CO., INC.
60 East 42nd Street, New York 17, N. Y.
WJ-2

Gentlemen:

Please send to me by return mail a copy of the "Bumblebee" AC Machine Catalog (ADW-53).

NAME ..... TITLE .....

FIRM .....

ADDRESS .....

CITY ..... STATE .....

LAMP CUTS WELDING TIME 20 PER CENT

Research Engineer A. B. White, welding expert for the Westinghouse Electric and Manufacturing Co. is shown testing a new lighting system he is developing to speed on welding of airplane parts and other war equipment. Directed on the part being welded, the lamp's brilliant beam enables the welder to see what he is doing through the dark glow window in his hood. This eliminates raising the hood between each weld to position the welding rod. The resultant saving in time for most welding jobs is 20% plus a reduction in amount of work and materials spoiled by touching the welding rod at the wrong point on the pieces being welded.

Fig. 1—Westinghouse Research Engineer A. B. White Testing New Lighting System He Is Developing to Speed Arc Welding

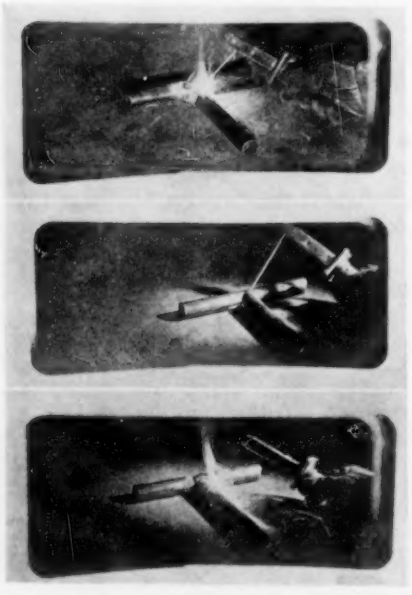


Fig. 2—What the Welder Sees Through the Window of His Hood

What the welder sees through the window of his hood is illustrated in these three views. In the upper one the brilliant arc provides the only light for the welder to see by and when it goes out the welder is blind and must raise his hood to position the welding rod. The difficulty of seeing what is being done through the glare of the arc is clearly illustrated. The center view shows how easily the welder can see through the glass of his hood to position the welding rod as the powerful lamp supplies ample light on the work. The bottom view is visual proof of the brilliance of the beam for even with the arc struck, the surrounding brightness is apparent and the glare of the arc has been effectively minimized resulting in easy and accurate seeing.

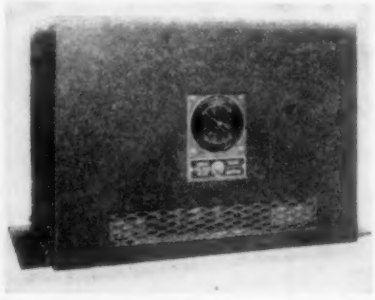
THYRATRON WELDING CONTROL

A new thyratron welding control for providing precise control of low-capacity spot welders has been announced by the Industrial Control Division of the General Electric Co. Coupled with a suitable welding transformer, this control can be used with either welding tongs or a small bench welder, and is particularly suitable for the spot welding of vacuum tube parts.

Other applications for which the control, in combination with the proper welding transformer, is desirable include the welding of solid or stranded wires to terminals of copper, brass, bronze, steel or ferrous alloys; joining two tinned-copper, steel or alloy wires; and spot welding thin pieces of various alloys.

The new control is mounted in a compact, dead-front metal enclosure designed to permit the control to be attached either to the top of the assembly bench or underneath, by a simple reassembly of parts.

Additional information is contained in Bulletin GEA-4175, available from the General Electric Co., Schenectady, N. Y.



WELDED CRADLES

Rolled Rod Stock is stored safely, quickly and neatly with cradle supports. The cradles pictured are the type used by Westinghouse Electric and Manufacturing Co. and are of $1^1/_4$-in. bar stock designed to accommodate rolled stock of medium diameter. Flanges are welded on the inside to prevent the rods from being rolled in the cradle and on the outside to prevent the cradle from being moved out of vertical position. These cradles can be moved from one part of the plant to the other since they are not bolted to the floor. In spite of this mobility, they hold rod stock securely and safely.

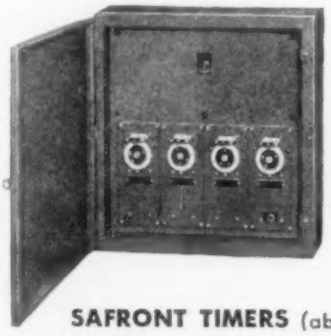
EUTECTIC ANNIVERSARY LUNCHEON

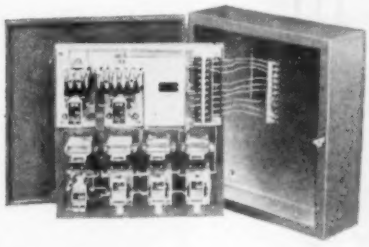
The technical press was invited to witness demonstrations of low-temperature welding techniques on the occasion of the Third Anniversary celebration of the formation of Eutectic Welding Alloys Co., New York. The demonstrations were preceded by a lecture by R. D. Wasserman, President, who stated that some 40 different alloy rods and fluxes have been developed for joining various metals. The demonstrations included physical tests of the welded joints.

MORE PRODUCTION WITH LESS OPERATOR SKILL *when resistance welders have* SQUARE D *Automatic* CONTROL

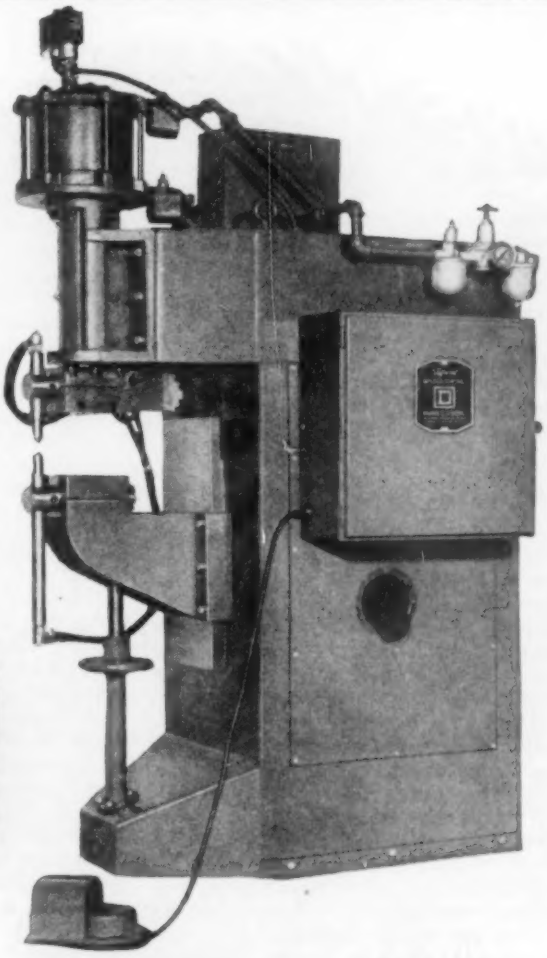
● Consistently good resistance welding at high production rates requires automatic control of pressure and current in an accurately regulated sequence. Square D welder control meets those requirements—exactly. It is simply designed, easy to install and maintain. With Square D automatic control on the job, very little operator skill is required—a vital angle during today's scarcity of skilled manpower.

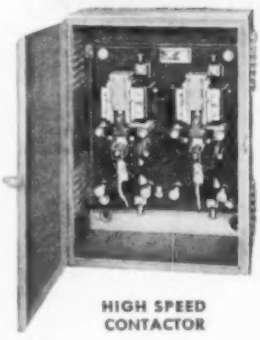
Specify Safront timers and Syncro-Break or High Speed contactors on new welding machines. Or, if increased quality and production is needed from present machines, find out how easily they can be equipped with automatic control. Consult your nearest Square D Field Engineer.



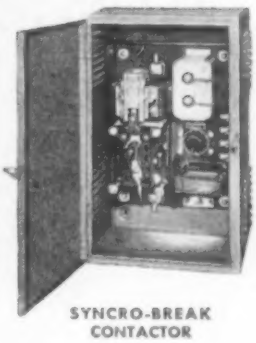


SAFRONT TIMERS (above) are built in 18 NEMA standard types. Notice, in upper left photo, how all electrically energized parts are behind a protective panel, yet calibrated timer adjustments are accessible on panel front. Separate timing devices, provided for each step of the welding cycle, are individually adjustable from 3 to 100 cycles. Safront interiors "swing out" (upper right photo) to expose operating parts.





HIGH SPEED CONTACTOR



SYNCRO-BREAK CONTACTOR

HIGH SPEED AND SYNCRO-BREAK CONTACTORS (right) possess unusual design features necessary for frequent making and breaking of the welding transformer primary circuit. The Syncro-Break design includes means for opening circuit without arcing at contact tips, thus increasing contact life and allowable ratings.

ELECTRICAL EQUIPMENT • KOLLSMAN AIRCRAFT INSTRUMENTS

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SECTION ACTIVITIES

BOSTON

This Section was pleased to have F. C. Fyke, New England-New York District Vice-President as dinner speaker at the February meeting. Mr. Fyke was introduced by a former District Vice-President from this Section, P. J. Horgan. For the technical program John B. Wilbur, Professor of Structural Engineering at the Mass. Institute of Technology, gave a very interesting talk on the "Design Construction and Operation of the Smith-Putnam Wind Turbine." Many lantern slides were used showing details and construction views of the turbine.

At the March 13th meeting A. K. Seemann, The Linde Air Products Co., New York, spoke on "Flame Hardening." Being well qualified to discuss this subject, he brought those present up to date on its applications. As an added feature, the sound motion picture "War Department Report" was shown.

CHATTANOOGA

The Chattanooga Section of the AMERICAN WELDING SOCIETY met for its February session on Friday, the 11th, at The Hotel Patten. There were 23 members and guests who joined in welcoming the speaker for dinner and 44 folks attended the technical session which followed the dinner.

The speaker of the evening was G. N. Seiger, president and general manager of the S-M-S Corp. of Detroit, who chose as his subject "Resistance Welding." His talk was both interesting and informative. Mr. Seiger had actual examples of various parts and metals which had been joined by resistance welding and his talk precipitated a lively question and answer period afterward.

Following the talk by Mr. Seiger a U. S. Navy picture entitled "December 7th" was shown.

A growing interest in the Chattanooga Section continues and new members are constantly being added. The meeting held in March was devoted to "Fabrication of Welded High-Pressure Piping" with R. W. Emerson of Pittsburgh as the speaker. It was gratifying to note the number of out-of-town industrial concerns from such points as Nashville and Knoxville who were represented at this session.

CHICAGO

The Chicago Section of the AMERICAN WELDING SOCIETY held its February meeting February 18th at the People's Gas Light and Coke Co. Auditorium in Chicago. The guest speaker of the evening was Walter J. Brooking, Director of Testing and Research, R. G. LeTourneau, Inc. Mr. Brooking spoke on the subject "The Effects of Procedure Control on Quality and Cost of Arc Welding." His talk outlined the procedure control problems that confronted R. G. LeTourneau, Inc., and how they were overcome. He also pointed out how the cost of manufacture of heavy earth-moving equipment was greatly reduced by the development of proper arc-welding procedure and techniques. This highly informative talk was illustrated by a number of slides picturing the various welding operations in the LeTourneau plant. So that the audience might have a better understanding of the uses of the various pieces of earth-moving equipment discussed, Mr. Brooking preceded his talk by showing two movies dealing with the manner in which the United States Army Engineers used this equipment in conjunction with their various fighting front activities.

The meeting was followed by a lively discussion, some of which took the speaker far afield from his announced subject.

CLEVELAND

The April 12th meeting of the Cleveland Section will be slightly different in that there will not be a dinner. The meeting will start at 7:30 P.M. at which time Ch. Engr. O'Callahan will tell of his memoirs of 25 years in H.M. British Navy. This will be followed by a movie and talk on "Unionmelt, Automatic Welding in War and Postwar Production," by E. D. Morris of The Linde Air Products Co. The main talk will be followed by a free buffet luncheon in the Dining Room. The meeting will be held in the auditorium of The Cleveland Engineering Society, 2136 East 19th St.

This past year has been very successful for the Cleveland Section from the standpoint of meetings and also the fact that several new energetic committeemen have been uncovered who are sure to contribute many new ideas to build up the Section.

The following is the program of the Cleveland Section Symposium to be held on May 12.

Afternoon Session, Fred Plummer, Toastmaster

First Speaker: W. Conley, The Lincoln Electric Co.

Subject: "New Production Welding Techniques." Time: 2:00 P.M.

Second Speaker: Jack Spence, General Sales Manager, Stoody Co. Subject "Hard Surfacing." Time: 3:00 P.M.

Third Speaker: A. G. Bissell, Bureau of Ships. Subject: "Stress Control Ship Welding." Time: 4:00 P.M.

Evening Session, G. N. Sieger, Toastmaster

First Speaker: David Arnott, President, AMERICAN WELDING SOCIETY.

Second Speaker: B. F. Stout, Stout Laboratories.

COLUMBUS

The regular monthly meeting of the Columbus Section was held on March 10th at the Southern Hotel. Roy Norton of Ampco Metal, Inc., discussed the subject, "Welding with Aluminum Bronze."

CONNECTICUT

The March meeting of the Connecticut Section was held on the 9th at the General Electric Institute, Bridgeport. R. T. Gillette, Res. Welding Engineer, General Electric Co., presented an illustrated address on the "Applications of Resistance Welding."

DETROIT AND FLINT

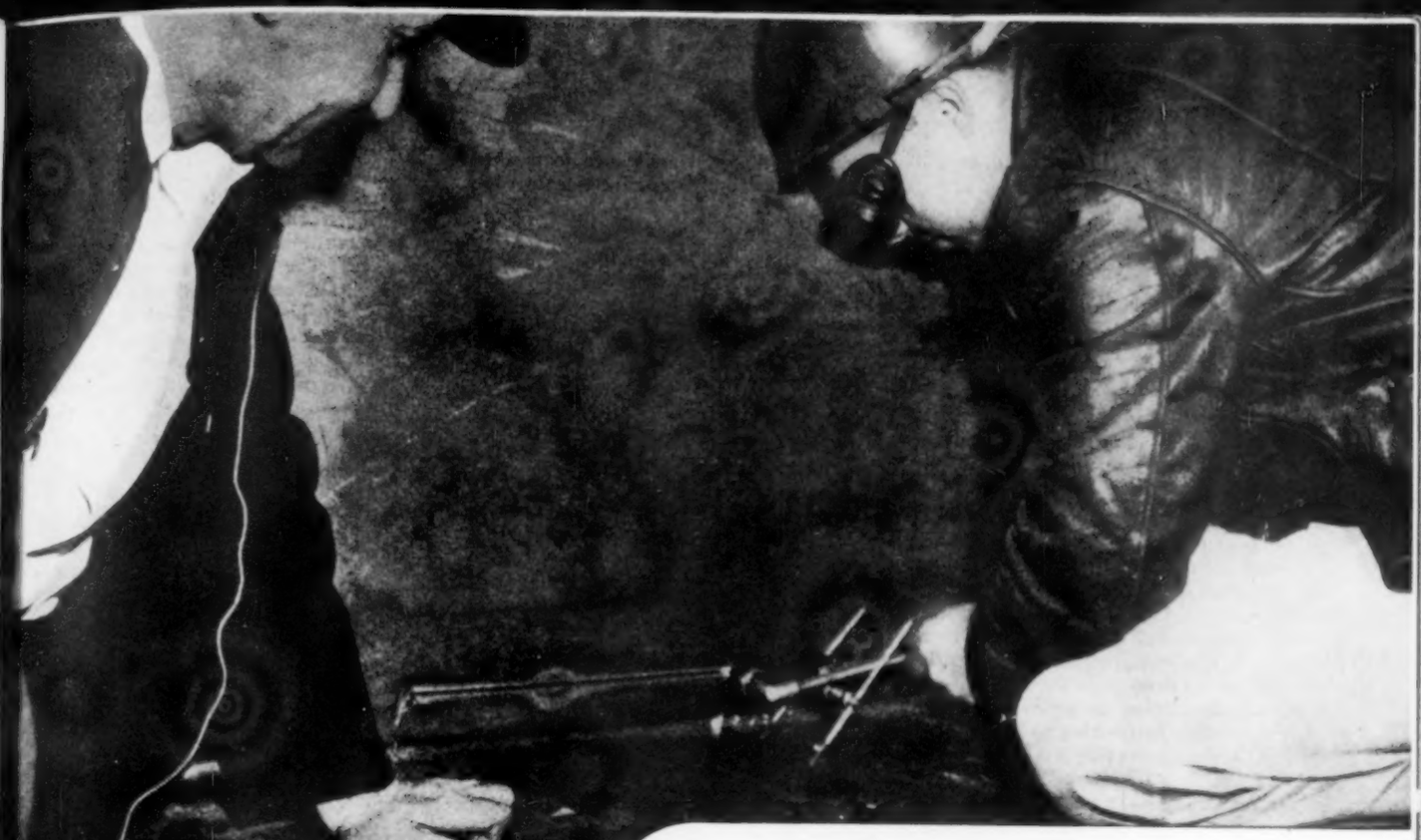
The Detroit Section meeting held on March 3rd was purely a local night. Both speakers hailed from the Detroit Section. A. L. Munson, Frostrode Division of Algoma Products, presented the first paper on the program on "Refrigerated Electrodes." In this he developed the improvement in performance from his process and quoted reports from R.P.I. and other technical institutions to substantiate his findings.

The second speaker was G. N. Sieger, S-M-S Corp., who spoke on "Resistance Welding Electrodes and Holders." In this presentation the fundamentals of resistance welding were reviewed and stressed, as well as the properties of the classes of electrodes used in resistance welding.

The Section's congratulations were extended to W. R. Stickney of the Canadian Bridge Co., who was recently awarded the Duggan Medal and Prize of the Engineering Institute of Canada for 1943 for his paper entitled "Electric Arc Welding."

April 7th was "Navy Night" for the Detroit Section. The speaker for the evening was Commander O. R. Sutherland, U.S.N. The topic of his presentation was "The Theory and Use of Specifications to Expedite and Control Production." The talk was preceded by a movie on the "Thermit Welding of Stern Frames for Ships."

The Flint group met on Thursday evening, March 2nd. A most enthusiastic reception was accorded the speaker, William Phillips of the General Motors Research Laboratories, whose topic was, "Plastics: Applications in Automotive Construction." Mr. Phillips had with him an interesting and unusual exhibit of



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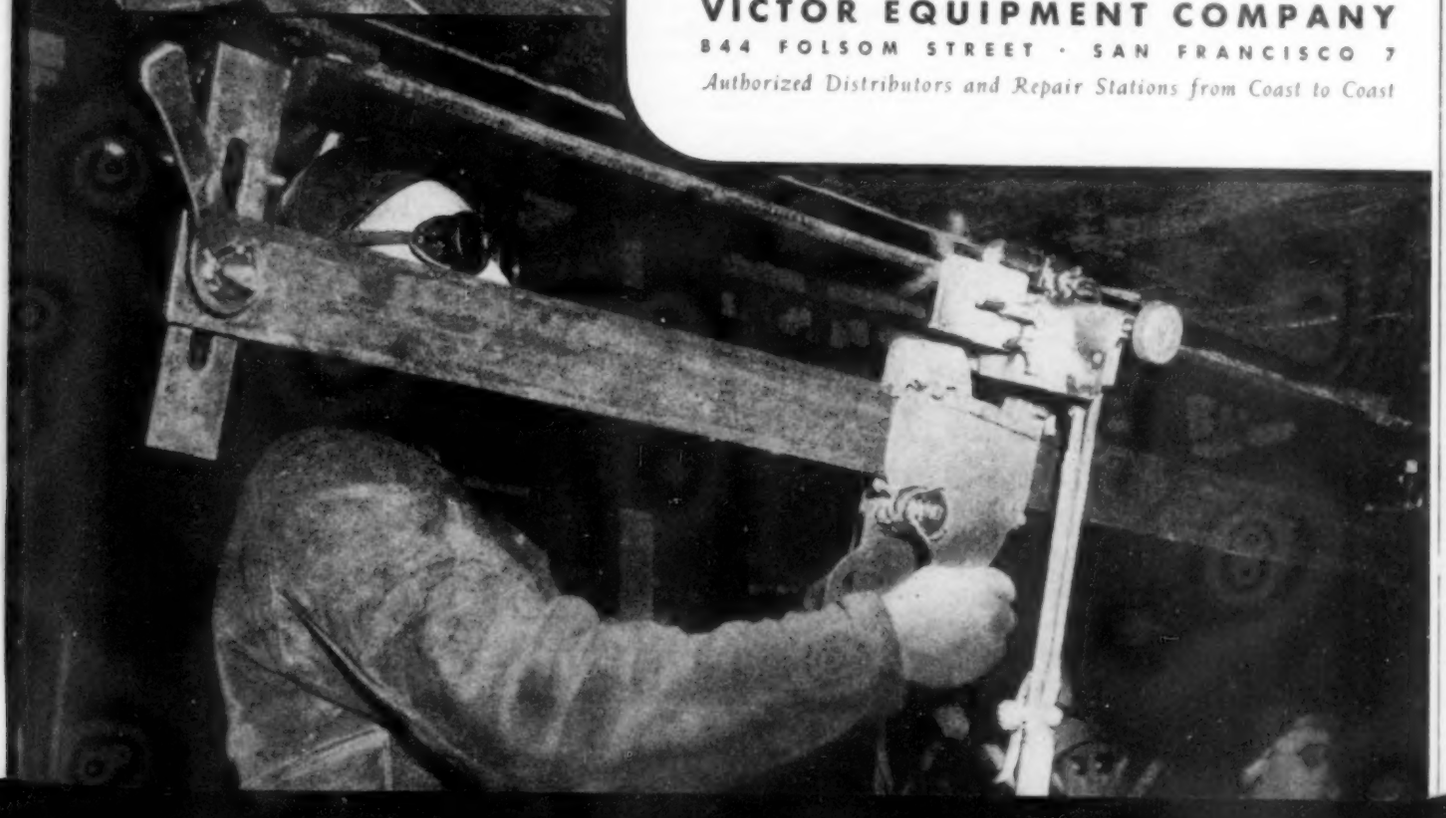

articles and designs in plastics to illustrate his presentation.

The April meeting of the Flint group was held on the 6th at Frankenmuth. Commander O. R. Sutherland spoke on "The Theory and Use of Specifications to Expedite and Control Production."

KANSAS CITY

The February meeting of the Kansas City Section of the AMERICAN WELDING SOCIETY was held Tuesday evening, February 8th, at Fred Harvey's Pine Room.

After a very successful campaign of arousing interest in these meetings, the largest crowd of the year was on hand to greet our speaker of the evening William M. Rogerson, Welding Engineer, Pittsburgh Plant, Aluminum Co. of America.

Mr. Rogerson's subject "Aluminum Welding" was amply illustrated with samples and cutaway sections as well as slides and a moving picture. The talk was particularly interesting to those who are now doing fabricating work in aluminum and also was interesting and enlightening to those of us who are contemplating the future use of aluminum. The various methods of joining aluminum parts was of great interest and hold great possibilities for research in other alloys and metals.

LEHIGH VALLEY

The regular monthly meeting of the Lehigh Valley Section of the AMERICAN WELDING SOCIETY was held at the Hotel Bethlehem, Bethlehem, Pa., on Monday March 6th, with 85 members and guests present. Chairman H. W. Lawson presided.

The subject for the meeting was "Structural Fabrication by Resistance Welding." The speaker of the evening was R. T. Gillette of the General Electric Co., Schenectady. Mr. Gillette's talk, which was illustrated by slides, covered the latest advances in Resistance Welding Controls and a Program Control for Welding and Heat Treating of Materials particularly adapted to structural steel fabrication. In order to produce good resistance welding economically, proper design, modern machines, precise control, careful selection and cleaning of material, good maintenance of equipment, well-trained personnel and competent inspection are essential.

The next regular meeting was held on Monday, April 3rd, at the Hotel Bethlehem. At which time R. A. Pomfert of the Bethlehem Shipbuilding Corp. spoke on "Welding Castings in Shipbuilding."

LOUISVILLE

The Louisville Section in connection with the War Production Board arranged for a Welding Panel on February 9th. Theodore Lewis of the Jeffersonville Boat and Machine Co. acted as Chairman.

Mr. Lewis pointed out that the War Production Conference is a cooperative effort to assist in the solution of manufacturing problems. In fact, he stated that it was a clinic for the exchange of practical ideas in production methods, which would be of assistance to production men, shop superintendents and foremen.

Assisting in this work were G. W. Plinke, who acted as Co-Chairman; Henry V. Heuser, Secretary-Treasurer of the War Production Advisory Committee; Murray Davis, in charge of registration, and R. C. Ernest, Chairman of the Panel Session Committee. Approximately 100 people attended the Conference.

The first talk was on "Job Instruction Training" by Geo. Kellogg of the Jeffersonville Boat and Machine Co. Mr. Kellogg stressed the importance of training methods, the job of the supervisor, safety, encouragement of workers and the like.

The second talk was given by H. C. Powers of the American Air Filter Co., on "Proper Arc Welding Sequence." Mr. Powers stressed the importance of proper procedure and use of suitable currents and sequence in the welding of light plates to prevent distortion. Numerous samples were used to illustrate the different points.

The third talk was given by J. W. Rolli of the Republic Welding Co., on "Job Shop Welding, Metallizing and Parkerizing." Mr. Rolli emphasized the part metallizing has played in the salvage of materials such as bearings and crankshafts, and illustrated on the blackboard the proper procedure necessary to build up a crankshaft.

R. E. Morrison of the Kentucky Metal Products Co., gave the fourth talk on "Maintenance of Jig and Equipment." He also covered the desirability of inspection of parts for wear, proper location of connections and equipment.

The fifth talk was on "Marine Piping" by E. Bethel of Tube Turns, Inc. Mr. Bethel pointed out that more than six hundred million feet of piping was required for newly constructed ships. There are between three to four thousand welds on each vessel such as manifolds, headers, elbows and return bends.

R. L. Hochstrasser of J. W. Greathouse Co., presented the sixth talk on "Subassembly and In-Place Fabrication." Mr. Hochstrasser pointed out that preforming produces better work and assists in preventing distortion.

The seventh talk was given by G. W. Plinke of the Henry Vogt Machine Co., on "Salvage of High Speed Tool and Die Blocks." Mr. Plinke brought out the precautions necessary in welding 0.35% carbon material used in high-speed tool steel and die blocks. He stressed the importance of proper procedure and materials.

After each one of these talks, the audience was permitted to ask questions and on numerous occasions there was considerable discussion and comments which displayed interest and enthusiasm.

MARYLAND

T. B. Jefferson, Editor of *The Welding Engineer*, presented an interesting talk entitled "What is the Postwar Welding Outlook" to the members of the Maryland Section, and their guests, at the February 4th meeting. About 55 members and guests attended.

MILWAUKEE

The regular monthly meeting, preceded by dinner, was held on February 25th at Cudworth Post, American Legion, Milwaukee. The welding address was given by T. B. Jefferson, Editor of *The Welding Engineer*, who spoke on postwar possibilities of welding. Mr. Jefferson pointed out how the war has increased the use of welding and as a result of this use welding will become an important part of the postwar.

NEW JERSEY

The February meeting of the New Jersey Section was held on the 15th at the Essex House, Newark. As usual, dinner preceded the technical meeting. R. J. Allend and R. T. Pursell of the Worthington Pump and Machinery Corp., presented illustrated talks on "Nondestructive Testing Methods." A film on Magnaflux Testing was shown.

NEW YORK

The New York Section held its regular monthly meeting on Monday, March 13th, at the Engineering Societies Building. W. Spraragen, Editor of THE WELDING JOURNAL, presided as Technical Chairman.

Speaker for the evening was H. Malcolm Priest, Engineer, Railroad Research Bureau. U. S. Steel Corp., Pittsburgh. The subject of Mr. Priest's talk was "The Practical Design of Welded Steel Structures." Mr. Priest covered the basic principles of welding as applied to structural steel, with particular emphasis on how these principles affect design calculations. The talk was accompanied by numerous lantern slides which illustrated these principles in the welding of structural steel for bridges and building.

At the conclusion of his talk, Mr. Priest presented the new U. S. Steel motion picture "To Each Other."

The evening opened with the regular half-hour question and answer period which was conducted by C. Kandel, Craftsweld Equipment Company, L. I. C.

NORTHWEST

H. S. Card of the Formed Steel Tube Institute spoke on "Structural Welding with Tubular Sections" at the February 16th meeting. Mr. Card's talk was illustrated by motion pictures. This meeting was of interest to those engaged in the fabrication of all types of structures and equipment involving steel frame work, as well as those engaged in the manufacture of boilers, heat exchangers and other types of heat transfer equipment.

PHILADELPHIA

The Philadelphia Section held its February meeting on Monday the 21st. Robert H. Pool, Supt., Electrical Department, Truscon Steel Co., gave an excellent talk on the conversion of their plant from peacetime operations to full time war production. He showed very clearly the increased importance of welding, discussed several of the electrical

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as well as the technical problems in setting up for all-welded construction.

On Friday, March 3rd, the Philadelphia Section held another of its A.W.S.-WPB panel discussions. This time the subject was "Pipe Welding," and the speakers were John Lang, of the New York Shipbuilding Corp., and J. G. Brown of the Atlantic Refining Co. Sixty-five welding engineers and welding foremen attended this discussion, which turned out to be a very lively session on Pipe Welding Methods and Procedures.

PITTSBURGH

A paper and discussion on "An Interpretation of Gas Welding Metallurgy for Non-Metallurgists," was presented at the February 16th meeting in the Mellon Institute of Industrial Research by Homer R. Morrison, Technical Instruction Engineer, The Linde Air Products Co., New York.

The paper devoted particular attention to ferrous metallurgy and was presented in a manner to assist in visualizing certain principles of metallurgy which are tied in with gas welding.

PUGET SOUND

The February 24th meeting held at the Gowman Hotel, Seattle, had an attendance of 140. A. G. Bissell, Senior Welding Engineer, Bureau of Ships, gave a very interesting talk on Welding Sequence, and showed a movie on "The Raising of the *Normandie*."

ROCHESTER

The March 2nd meeting at the Powers Hotel was preceded by a dinner. T. R. Lichtenwalter of the Republic Steel Co., spoke on the subject, "Welding and Fabrication of Stainless and Heat-Resisting Alloy Steels." Mr. Lichtenwalter's talk was enthusiastically received.

ST. LOUIS

The St. Louis Section held their regular monthly meeting Feb. 11th at the Engineers' Club of St. Louis, the speaker for the evening being R. W. Vanderbeck, Research Metallurgist for the Allegheny-Ludlum Steel Corp., Brackenridge, Pa., on the subject of "Stainless Steel Welding." Mr. Vanderbeck's treatment of the subject had mainly to do with the welding of 17% chrome steel, comparing welds made on this material with various stainless electrodes, including 17% chrome, 18/8, 18/8 Cb, 25/12, and 25/20. Comparisons of the various welds were made for various heat treatments, indicating the resulting variation and corrosion resistance, hardness, ductility and tensile strength.

In addition to the above a sound color movie was shown on the welding of stainless steel, and also a sound color movie showing the operation of a new high-speed camera, which is called the Micro-Timer, developed by the Bell Telephone Co. The possibilities of the Micro-Timer were illustrated by several slow-motion movies made of the action of cutting tools in machining operation.

The meeting was attended by 125 members and guests.

SAN FRANCISCO

The February 25th meeting was a dinner meeting. The Coffee Talk was given by W. J. Miskoe, Manager, Lincoln Electric Co., Australia, who spoke on the Australian reaction to Americans and American ways. His repertoire of anecdotes on the side lights of the war in the South Pacific are unlimited.

The Technical Talk was given by Roy O. Schiebel, Jr., of the Magnaflux Corp., who spoke on the nondestructive inspection of material.

An authentic Army-Navy sound motion picture recording the actual landing and fighting in the capture of Tarawa and *Bismarck* convoy was shown.

SOUTH TEXAS

Karl Luger, Metallurgical Engineer for Jessop Steel, talked on the subject of Stainless and Stainless Clad at the February 10th meeting of the South Texas Section. Government films were shown and refreshments were served.

SYRACUSE

The March meeting of the Syracuse Section was held in the Syracuse Museum of Fine Arts on the 19th. Five reels of a General Electric film, "The Inside of Arc Welding," were shown. After this interesting and educational movie, the official U. S. Navy movie of the "Life and Death of the Aircraft Carrier, U.S.S. *Hornet*," and later another Navy film, "Full Speed Ahead," which dealt with the progress made in the development of Destroyer Escort Vessels and the work which they are doing to combat the Submarine Menace, were shown. The meeting was attended by forty-one members and forty-one guests.

WESTERN MASSACHUSETTS

James R. Craig of The Linde Air Products Co. presented an illustrated talk and movie on some new developments in gas cutting and plate preparation, at the February 28th meeting held in the Holyoke Trade School.

Following this presentation, a movie "Wire" was shown through the courtesy of the Bethlehem Steel Corp.

YORK-CENTRAL PENNSYLVANIA

Roy A. Mansfield, Welding Engineer and District Manager of the Southern Oxygen Co., presented an informal talk on Health Hazards, at the March 8th meeting.

York-Central Pennsylvania Night—Annual Meeting and Banquet—will be held on Wednesday, April 12th, at 7:00 P.M. in the Alcazar Ball Room, 205 South George St., York, Pa.

Employment Service Bulletin

SERVICES AVAILABLE

A-471. Metallurgical Engineer desires increased responsibility in research and development of coated electrodes for arc welding. Several years of productive experience in flux formulation on all types of steel rods. Signal ability with ferritic or austenitic stainless and a.-c. work.

A-472. Fourteen years' experience in the welding field as welder, government instructor, foreman and welding engineer on all types of welded fabrication. Desires position in the supervisory class preferably to head up a welding department for a large organization or as welding engineer.

POSITIONS VACANT

Metallurgists—Welding Engineers. Men wanted for research and experimental work on welding techniques and materials. Graduate metallurgists preferred. Write for application. Battelle Memorial Institute, Columbus 1, Ohio.

V-138. Welding Engineer with practical background, as well as a good technical one, particularly in the subject of Submerged Arc Welding. Essential to have executive ability to be in charge of research and development work in the welding field.

V-139. Arc Welding Sales Managers. Large welding equipment and electrode manufacturer now establishing direct sales organization. All Eastern centers open. Men picked now best opportunity becoming territorial Sales Managers. Experience required. Salary. Replies confidential.

V-140. Wanted—Engineer with extensive experience in Resistance Welding of Stainless Steels. Location West Coast. Salary commensurate with experience.

V-142. Welding Sales Engineer. We require the services of a welding sales engineer to assist in the sale and demonstration of welding electrodes in the Philadelphia area. This party should be familiar with all phases of welding including the various Codes and engineering designs. Prefer ex-service man, or draft exempt.

V-143. Electrode Coating Development—A man who is familiar with all types of coatings principally carbon steel to assist in development and research.

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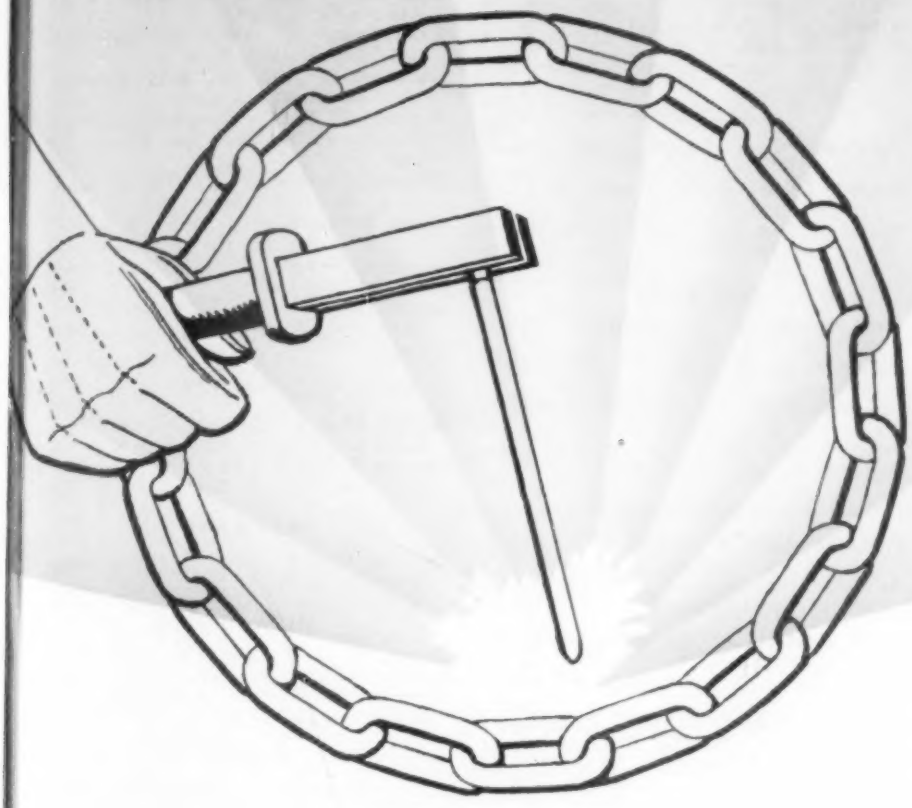

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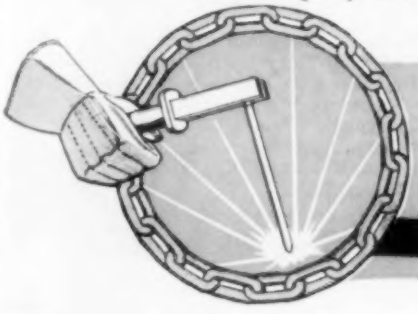

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List of New Members

February 1 to February 29, 1944

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Crighton, William M. (B), 951 Southern Artery, Quincy 69, Mass.
Kelly, A. J. (C), Grinnell Co., 260 Exchange St., Providence, R. I.
Ruggiero, Rico L. (C), 19 Oliver St., Milford, Mass.
Santacroce, Joseph (B), Fish Pier, Boston, Mass.
Titus, Leonard W. (C), 38 Mayfair Rd., Edgewood Sta. 5, R. I.

CANADA

Brulotte, J. Engelbert (C), 12 Bouchard St., Lauzon City, Que., Canada.
McIntee, Ross (F), 15 Ottawa St., St. Catherine's Ont., Canada.

CHATTANOOGA

Brock, J. A. (C), Rt. 4, Box 55, Rossville, Ga.
Bryant, T. P. (C), 209 Old Mt. Rd., Chattanooga, Tenn.
Naar, Peter S. (C), 7 Wann Apts., Chattanooga 3, Tenn.
Wolkin, Marvin (C), Combustion Engrg. Co., 1032 W. Main St., Chattanooga, Tenn.

CHICAGO

Bedell, A. E. (B), % Graver Tank & Mfg. Co., E. Chicago, Ind.
Beecher, S. B. (B), 1754 W. 104th Pl., Chicago, Ill.
Bieker, L. W. (B), 1154 Ridge Rd., Hammond, Ind.
Birkett, G. R. (B), 1117 Beacon St., E. Chicago, Ind.
Chuma, Steve F. (C), 2106 N. Harlem Ave., Elmwood Park 35, Ill.
Devaney, William A. (C), 3441 W. Ohio, Chicago 24, Ill.
Fleetwood, James (C), South Shore Hotel, 808 W. Chicago Ave., Chicago, Ill.
Graver, P. S. (B), 10338 S. Seely Ave., Chicago, Ill.
Jancovic, Albert (C), 2657 Clybourne Ave., Chicago 14, Ill.
Mack, Walter E. (C), 7259 Crandon Ave., Chicago, Ill.
Miller, Frank R. (C), 1743 W. Huron St., Chicago 22, Ill.
Kardevan, Frank C. (C), 7515 S. Kingston Ave., Chicago, Ill.
Koch, Otto K. (B), Box 91 W, R.R., Blue Island, Ill.
Meers, Thomas G. (B), 410 Detroit St., Hammond, Ind.
Mineur, Ivan (B), Lincolnshire, Crete, Ill.
Morrison, Thomas G. (B), 7138 Constance Ave., Chicago 49, Ill.
Parsons, W. R. (B), 10924 S. Artesian Ave., Chicago 43, Ill.
Rivers, George W. (B), 3425 Black Oak Rd., Hammond, Ind.
Roskopf, Adam (C), 2632 N. Wayne Ave., Chicago, Ill.
Smith, Hubert (B), Graver Tank & Mfg., Co., Inc., E. Chicago, Ind.
Squire, F. G. (B), 5069 W. Madison St., Chicago, Ill.
Ulm, Reign C. (B), Graver Tank & Mfg. Co., E. Chicago, Ind.
Wilkin, L. A. (B), % Graver Tank & Mfg. Co., E. Chicago, Ind.
Zeidler, Harold P. (B), Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.

CLEVELAND

Bornholdt, C. J. (B), 14 E. 220th St., Euclid, Ohio.
Helder, Leland G. (B), Box 241, N. Canton, Ohio.
Spalding, Tom (B), 1240 Oxford Rd., Cleveland Hts., Ohio.

COLUMBUS

Alten, George H. (B), 226 W. Wheeling St., Lancaster, Ohio.
Bishop, B. G. (B), 608 S. Main St., Ada, Ohio.
Lee, Fred A. (B), International Harvester Co., Springfield, Ohio.
Smith, Robert W., Jr. (C), 2257 Groveport Pike, Columbus 7, Ohio.

CONNECTICUT

Florian Richard H. (B), Trumbull Electric Mfg. Co., Plainville, Conn.

DETROIT

Arter, Charles O. (C), 2220 Mayburn Ave., Dearborn, Mich.
Calley, Joe L. (B), 1088 Meldrum Ave., Detroit, Mich.
Leininger, Harold L. (B), Composite Forgings, Inc., 2300 W. Jefferson Ave., Detroit 16, Mich.
Miller, Edwin C. (C), 714 E. Sixth St., Flint, Mich.
Pound, Earl (C), 2110 Grand Blanc Rd., Grand Blanc, Mich.
Puse, Ervin C. (B), 37 E. Pleasant St., River Rouge, Mich.
Roberts, Fay H. (B), 3326 Cheyenne St., Flint, Mich.
Selberg, Eugene E. (B), 101 Mechanic Ave., Parkside Apt. 218, Pontiac, Mich.
Stumpf, John F. (C), 33745 Firwood, R.R. 2, Wayne, Mich.
Turner, Clayton L. (C), 954 Chevrolet Ave., Flint, Mich.
Van Arsdale, James L. (B), 12652 Washburn Ave., Detroit 4, Mich.
Van Riper, Elton S. (B), Rt. 2, Holly, Mich.
Voss, William F. (B), 2226 Howe Rd., No. 3, Flint, Mich.
Warren, William H. (B), 126 Madison Ave., Flint, Mich.
Wolfe, Roy V. (B), 945 S. Ballenger Rd., Flint, Mich.

KANSAS CITY

Abbott, H. G. (C), Route 1, Kansas City, Kan.
House, Harold E. (C), 1525 Greeley, Kansas City, Kan.

LEHIGH VALLEY

Guenzel, Rudolph A. (B), 127 Bryn Mawr Ave., Bala-Cynwyd, Pa.

LOS ANGELES

Anderson, Conrad L. (C), 9928 Walnut Ave., S. Gate, Calif.
Elder, Lowell (C), 500 S. Marguerita St., Alhambra, Calif.
Gauthier, L. Jean (B), 5511 Archcrest Dr., Los Angeles 43, Calif.
Graham, W. B. (C), Harnischfeger Corp., 4439 Santa Fe Ave., Los Angeles 11, Calif.
Haynes, Charles L. (B), 722 E. Santa Ynez Lane, San Gabriel, Calif.
Hiller, Robert E. (B), Triplett & Barton, Inc., P. O. Box 267, Burbank, Calif.
Sandage, Ned R. (C), 2393 Wilma Ave., Los Angeles, Calif.
Smyth, Edward G. (C), Standard Oil Co. of Calif., 605 W. Olympic, Los Angeles 15, Calif.

LOUISVILLE

Bruner, Max T. (C), Ashland Oil & Refining Co., Ashland, Ky.
Doudna, Arthur B. (B), 311 W. Chestnut St., Louisville 2, Ky.

MARYLAND

Cochran, Cecil E. (C), 4700 Schley Ave., Baltimore 6, Md.

MILWAUKEE

Baker, J. J. (B), 2822 N. 15th Lane, Milwaukee 6, Wis.
Gorman, Earl P. (C), 3406 S. 39th St., Milwaukee, Wis.

MOBILE

Butler, James W. (C), 12 S. Reed Ave., Mobile 19, Ala.
Dick, Charles M., Jr. (C), 1309 E. Tyler Ave., Pascagoula, Miss.
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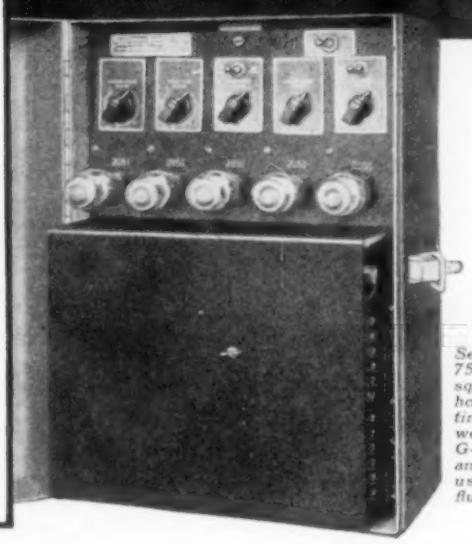

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A.S.T.M. COMMITTEE A-1 ON STEEL*

At well attended meetings of Committee A-1 on Steel and several of its subcommittees in Cincinnati detailed consideration was given to many of the 130 specifications in the charge of this group and several new activities were outlined. Several specifications for structural steel were reaffirmed and the renewal of studies on a specification for structural weldable steel for bridges and buildings was authorized.

Consideration of the desirability of setting up a maximum carbon limitation on certain types of ring and disk forgings, specifications A 243, when used for welding resulted in no action, leaving decision on this matter to governing codes. Of direct interest in this field is the development of two new specifications giving up-to-date requirements for carbon and alloy blooms, billets and slabs for reforging purposes which would include all of the widely used carbon and alloy grades, provide for agreement on ranges in chemistry and variations where special grades are required, and also provide for the invoking of a number of extra quality tests if desired by the purchaser—special finish, magnetic particle tests, etc.

As a tentative revision certain new grades will be proposed in the specifications covering alloy-steel forgings of the quenched and tempered class for industrial use with physical properties (depending on size classification) ranging from 135,000 to 170,000 psi. tensile strength, and elongations in 2 in. from 11 to 15 per cent.

There was, as usual, considerable activity in the field of pipe and tubing with provisions being established in the widely used pipe specifications A 53 permitting purchase of electric-resistance-welded pipe in 1/8-in. and 1/4-in. sizes. No tensile requirements would be required. There would be limitations on carbon and other provisions would be met.

In cooperation with Committee A-10 on Iron-Chromium and Related Alloys a joint subcommittee has been reviewing proposed specifications for corrosion-resisting pressure *tubing* for service in cracking stills, dairy and food industries, and for general purpose use, the latter involving both the austenitic and ferritic grades. Another problem is to bring existing chemical requirements on stainless steel *pipe* in line with the current supply situation and this problem was referred to the joint subcommittee for recommendations.

Because of the disproportionate "necking down" of the 8-in. specimens used in determining tensile properties of certain alloy-steel plates for use in boilers and pressure vessels, difficulty has been obtained in certain provisions. As a result, changes are in process which would provide that for plates 3/8 to 3/4 in. thick if the percentage of elongation of an 8-in. gage length test specimen falls not more than 3 per cent below the amount prescribed, the elongation shall be considered satisfactory if percentage in 2 in. across the break is not less than 30. This provision will take care of the decrease in percentage, of elongation which results as the gage length is increased.

In the field of castings for fusion welding for service at elevated temperatures the effect of stray elements was discussed in detail, but the committee will study the matter further. An emergency provision will be carried through setting up a grade of steel casting in the carbon steel class for high-temperature service (A 95) of 65,000 psi. for tensile strength. Chemistry provisions in the widely used chromium molybdenum bolting grade B7 (A 193), are to be modified to be brought in line with current practice.

Because of the incorporation of many of the A.S.T.M. steel specifications in the WPB limitation Order L211, and the present war situation, the large number of emergency alternate provisions which have been established to expedite procurement or conserve certain materials are in general being continued.

* Officers of Committee A-1 are: *Chairman*, N. L. Mochel, Manager, Metallurgical Engineering, Westinghouse Electric and Manufacturing Co., Philadelphia, Pa.; *Secretary*, H. P. Bigler, Assistant to President, Connors Steel Co., Birmingham, Ala.

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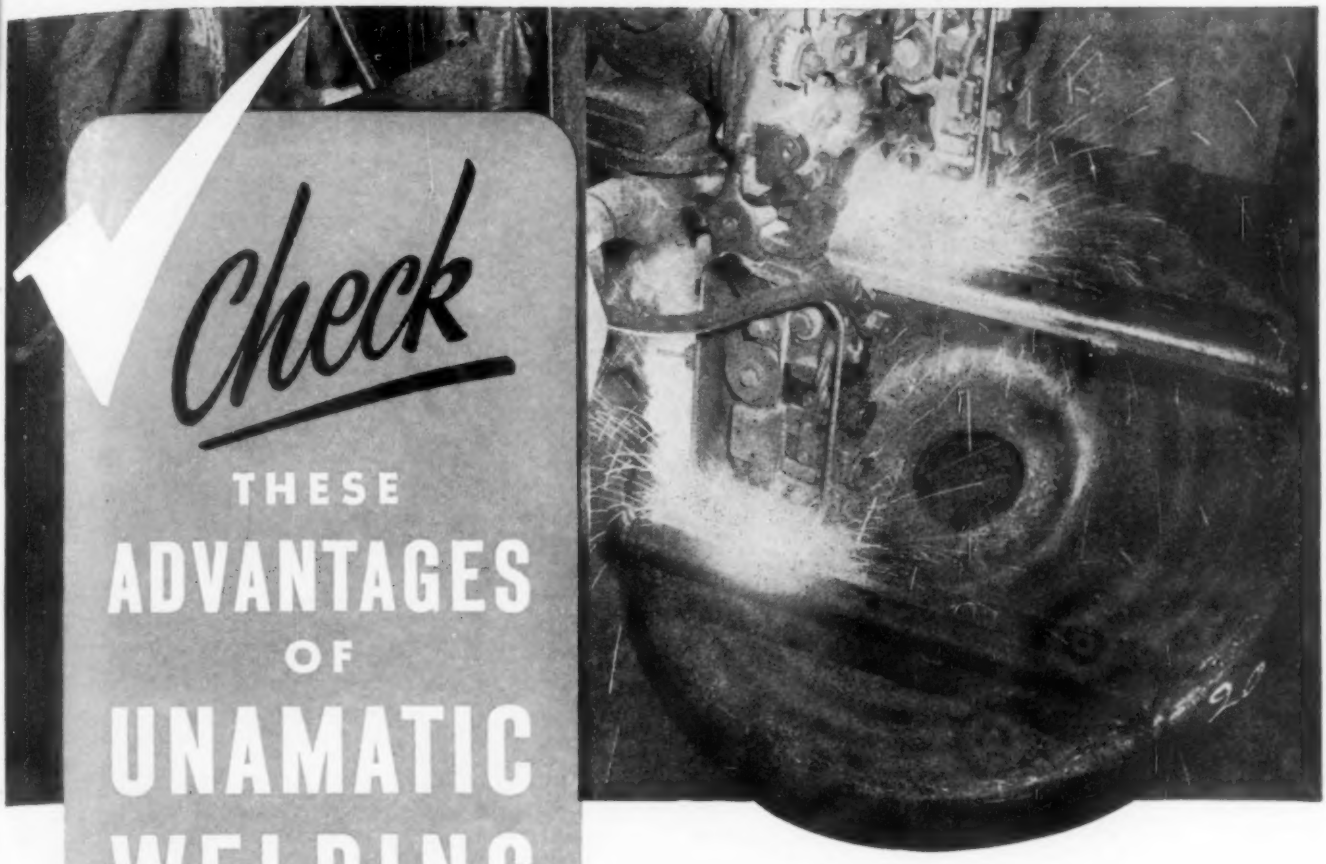

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SECRETARY—J. HOTCHKISS, Bentley Welding, Inc., Syracuse, N. Y.

TOLEDO

CHAIRMAN—LORENZO KENNON, 2436 W. Central Ave., Toledo, Ohio

SECRETARY—EDWIN NAFZGER, Toledo Steel Tube Co., 2105 Smead Ave., Toledo 6, Ohio

TULSA, OKLA.

SECRETARY—JAMES B. DAVIS, Tulsa Testing Labs., Tulsa, Okla.

WASHINGTON, D. C. — 2nd Tues.

CHAIRMAN—H. L. INGRAM, JR., Air Reduction Sales Co., 1823 L St., N. W., Washington, D. C.

SECRETARY—G. G. LUTHER, Naval Research Lab., Anacostia Station, Washington, D. C.

WESTERN MASSACHUSETTS — Last Mon.

CHAIRMAN—WILLARD A. EMERY, Worthington Pump & Machinery Co., Holyoke, Mass.

SECRETARY—J. J. KAPINOS, Worthington Pump & Machinery Co., Holyoke, Mass.

WESTERN MICHIGAN

CHAIRMAN—C. LANPHEAR, C. H. DUTTON Co., 630 Gibson St., Kalamazoo, Mich.

SECRETARY—R. D. LAYMAN, The Lincoln Electric Co., 200 Division Ave., Grand Rapids 2, Mich.

WESTERN NEW YORK — 3rd Fri.

CHAIRMAN—JOSEPH COUSINS, J. D. Cousins & Sons Boiler Wks., 667 Tifft St., Buffalo, New York

SECRETARY—R. S. LANE, Ross Heater & Mfg. Co., 1407 West Ave., Buffalo, N. Y.

WICHITA, KAN. — 2nd Wed.

CHAIRMAN—M. A. BARRETT, Beech Aircraft, Inc., Wichita 1, Kans.

SECRETARY—DON SCHWARTZ, Air Reduction Sales Co., 402 E. 29th St., Wichita, Kan.

YORK—CENTRAL PA. — 2nd Wed.

CHAIRMAN—E. E. ROUSCHER, A. B. Farquhar Co., York, Pa.

SECRETARY—C. E. LEWIS KERCHNER, R. D. No. 1, Thomasville, Pa.

YOUNGSTOWN, OHIO — 2nd Mon.

CHAIRMAN—ROBERT FISHER, 1534 Thomas Road, Warren, Ohio

SECRETARY—CARL J. HELTZEL, Hetzel Steel Form & Iron Co., Warren, Ohio